ARMY RESEARCH AND DEVELOPMENT

MONTHLY NEWSMAGAZINE OF THE OFFICE OF THE CHIEF, RESEARCH AND DEVELOPMENT
Vol. 8, No. 9 October 1967 • HEADQUARTERS, DEPARTMENT OF THE ARMY • Washington, D.C.

ABM Net Linked To Army Efforts

U.S. Army-developed antiballistic missiles (ABM) with multifunctional radars and other ground equipment will be linked to Secretary of Defense McNamara's plan for deployment of a $5-billion system oriented to the Communist Chinese threat.

An information sheet released Sept. 22 said the system will consist of 15 to 20 Spartan and/or Sprint missile batteries deployed throughout the United States. Specific sites will be announced later.

The Spartan "will provide for many years area coverage for the continental United States, Alaska and Hawaii against a Communist Chinese attack. . .with modifications at least to the 1980's," it was stated. Sprint will protect radars for the area defense and most Minuteman (Air Force) ICBM sites.

Expected to be fully operational in five to six years, the "thin screen" ABM system is slated to have its first battery in

(Continued on page 4)

Aircraft Engine Development Pushed

Advanced developmental contracts totaling $10,150,000 for the 1,500-Horsepower Demonstrator Engine Program, awarded by the U.S. Army Aviation Materiel Laboratories (AVLABS), Fort Eustis, Va., are considered of great potential importance to aircraft power needs.

AVLABS Commander Col Harry L. Bush announced award of a $6,400,000 contract to the Flight Propulsion Division of the General Electric Co. and a $3,750,000 contract to the Florida R&D Center at Pratt and Whitney Aircraft, a division of United Aircraft Corp., early in September.

The contracts are related to the Individual Components Technology Program in development of advanced aircraft engines that has been in progress at AVLABS for several years through U.S. Government-industry cooperation. Researchers are still cautious in predicting possibilities, but the program has stimulated increasing interest among aircraft firms.

Both of the contractors selected for the

(Continued on page 3)

ASC Slates Panel On Vietnam Needs

Army Science Conference participants who assemble about 500 strong June 18-21 at the U.S. Military Academy, West Point, N.Y., scene of the five previous ASCs, will hear a 4-hour panel discussion on "Combat Needs in Vietnam" as a highlight.

The planning and advisory committee, headed by Army Research Deputy and Scientific Director Dr. Richard A. Weiss, with Dr. John C. Hayes serving again as project officer, has developed the general objectives.

Basic research, for the first time, will be secondary to the lessons of pratical experience during the discussion of Vietnam medical problems, such as infectious

(Continued on page 3)

AMC Shifts Missile Plant From ATAC to MICOM

Control of the Michigan Army Missile Plant (MAMP), Warren, Mich., is being transferred from the Army Tank-Automotive Command to the Army Missile Command, Redstone Arsenal, Ala., by direction of the U.S. Army Materiel Command.

Command jurisdiction and plant cognizance are being transferred because most of the work performed there is missile-oriented. The effective date for the change was Sept. 30, but all arrangements will not be completed until Dec. 1 in order to effect an orderly transfer.

Approximately 100 employes operate from the MAMP contracting office and are engaged in contract administration and associated functions. They will con-

(Continued on page 5)

MUCOM Briefing Lists Needed R&D Advances

Scientific and technological advances required to develop concepts for significant gains in combat capability linked to long-range planning goals were defined by U.S. Army Munitions Command speakers at a classified industrial briefing Sept. 19-20.

Nearly 800 industrial representatives assembled in the Departmental Auditorium, Washington, D.C., for the first full-scale briefing of this type sponsored by the Munitions Command and Department of Defense in affiliation with the National Security Industrial Association (NSIA).

Banquet speaker Dr. Finn J. Larsen, Principal Deputy Director of Defense Research and Engineering, and former Assistant Secretary of the Army (R&D),

(Continued on page 6)

PRINCIPALS at industry-government briefing in Washington, D.C., Sept. 19-20, included, from left, Admiral Joseph Lyle (USN, ret.), NSIA president; Maj Gen Frank G. White, CG, U.S. Army Munitions Command; Dr. Finn Larsen, Principal Deputy Director of Defense Research and Engineering; Capt Robert N. McFarlane (USN, ret.), National Security Industrial Association past president.

Featured in This Issue . . .

CRD Cites Research and Development Response to Vietnam.....p. 2
ASA (R&D) O'Neal Discusses Project Management at Defense Weapons Systems Center.....p. 8
Army Research Office-Durham Publishes Basic Research Results.....p. 12
Chemical Information Data System Project Nearing Test Phase.....p. 17
United Kingdom Joins 3 Nations in Mallard Communications Project.....p. 18
Corps of Engineers Coastal Engineering Research.....p. 22
Report Outlines 20-Year Program to Alleviate Food Problem.....p. 25
Dr. Larsen Discusses Research and Development for Vietnam.....p. 28
Army Role in Fuel Cell R&D Aids Growth of Worldwide Interest.....p. 34
Demonstrated Destruction of Nuclear Weapons.....p. 40

Army R&D Newsmagazine

Vol. 8, No. 9 October, 1967

Editor . . . . . Clarence T. Smith
Associate Editor . . . . George J. Makuta
Assistant Editor . . . . . Read Wynn
Editorial Assistant . . . . . Dorothy Beck

Published monthly by the Army Research Office, Office of the Chief of Research and Development, Department of the Army, Washington, D.C. 20310, in coordination with the Technical and Industrial Liaison Office, OCRD. Grateful acknowledgment is made for the valuable assistance of Technical Liaison Offices within the U.S. Army Materiel Command, U.S. Continental Army Command, Office of the Chief of Engineers, and Office of The Surgeon General. Use of funds for printing of this publication has been approved by Headquarters, Department of the Army June 6, 1967.

Purpose: To improve informal communication among all segments of the Army scientific community and other Government R&D agencies; to further understanding of Army R&D progress, problem areas and program planning; to stimulate more closely integrated and coordinated effort among Army R&D activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

Picture Credits: Unless otherwise indicated, all illustrations are by the U.S. Army.

Submission of Material: All articles submitted for publication must be channeled through the technical liaison or public information officer at installation or command level.

By-lined Articles: Primary responsibility for opinions of by-lined authors rests with them; their views do not necessarily reflect the official policy or position of the Department of the Army.

DISTRIBUTION is based on requirements submitted on DA Form 12-4. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. 21220.

Distribution on an individual name basis is restricted to members of the U.S. Army Atomic Energy and R&D Officer Special Career Programs. Members of the U.S. Army Reserve R&D Unit Program receive distribution by bulk lot sent to their individual units. Otherwise, distribution is made only to the Army installation, office or organizational element to which the requester is assigned.

CHANGES OF ADDRESS for AE and R&D Officer Special Career Program enrollees should be addressed to: Specialist Branch, OPXC, Department of the Army, Stop 106 Washington, D.C. 20315. Reserve R&D Unit members should contact: Special Assistant for Reserve Affairs, OCRD, Department of the Army, Washington, D.C. 20310.

OTHER GOVERNMENT AGENCIES' requirements should be submitted directly to the Army Research Office, OCRD, Department of the Army, Washington, D.C. 20310, ATTN: Scientific and Technical Information Division.

ALL NON-U.S. GOVERNMENT agencies, firms and organizations must obtain this publication through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Single copies sell for 20 cents. Subscription rates (12 issues annually) are: Domestic, APO and FPO addresses, $2.25; Foreign, $3.00

CRD Cites R&D Response to Vietnam

Talks with U.S. Army commanders in Southeast Asia on a trip to determine how well R&D activities are responding to the more critical combat needs in Vietnam have satisfied Chief of Research and Development Lt Gen A. W. Betts that gains are substantial.

"Military successes and accomplishments are clear and abundant," he stated. ". . .We have made tremendous progress in making Vietnam safe for the Vietnamese. . . . The enemy has been pushed back into the jungle. . . . Roads closed a year ago to any traffic other than heavily armored convoys are now open to both military and commercial use. . . ."

Speaking at the recent annual dinner meeting of the Michigan Chapter of the Defense Supply Association in Detroit, General Betts said target acquisition is clearly the commanders' most severe problem in Vietnam.

The U.S. Army's first Advanced Aerial Fire Support System (AAFSS), the AH-56 Cheyenne aircraft now undergoing flight tests, will meet a "crying need," General Betts said, for the full system approach to locating and destroying the enemy.

Notable achievements of Army R&D in recent years include satellite communications systems, laser light beams that cut through metal, microminiaturization that can put electronic circuits on the head of a pin, and the Nike-X antimissile defense system that has demonstrated it can destroy a missile "that flies 10 times faster than a bullet."

In citing this progress, General Betts conceded the troublesome nature of many of the conditions currently being encountered against the Viet Cong by saying, "we have failed in attempts to solve a number of basic and seemingly infinitely simpler problems in South Vietnam.

"Actually, research and development efforts in support of operations in Vietnam have yielded hundreds of items of materiel that have been sent to South Vietnam for evaluation or operational use. I just had to see for myself why we couldn't make more of a contribution."

General Betts explained that he had to evaluate the final acceptance of items under development, and to explore the trade-offs between expedited development versus more deliberate and time-consuming development of equipment.

The visit of General Betts and his party also included talks with General Westmoreland's senior staff officers and with Lt Gens Stanley R. Larsen and Frederick C. Weyand, as well as with commanders of Combat Support units and Combat Service Support units in the Saigon area and Cam Ranh Bay.

After enumerating numerous successes that have prevented the enemy from accomplishing tactical goals of taking control of the northern provinces and of dominating the highlands, General Betts needled critics of the progress against the Viet Cong by quoting a general officer who is serving in Vietnam. He said:

"We seem to forget that about two years ago, by a narrow margin, we saved South Vietnam from being overrun. At that time our military leaders predicted that it would take at least five years and probably 10 to achieve our objective. We are an impatient people. This may be the nub of the problem.

"The confusion and frustration of the American people can be explained, in part, by our inability to identify our real progress in commonly used, understandable terms. We are so used to expressing military achievement in terms of terrain seized that we cannot apparently recognize full significance of other criteria.

"This is not to indicate that there is not a long way to go in the total effort in Vietnam. I strive to point out only that military and pacification gains have been much more significant than most of us have been led to believe.

"Commanders in World War II and earlier had to accept equipment made available to them and to do their job with that equipment. Today we can be more immediately responsive to new demands. It was satisfying, indeed, to visit division and lower headquarters and be briefed on user reaction to our equipment, and to hear of their requirements for completely new or improved systems."

General Betts said that the most encouraging recent development in detection devices to be evaluated in Vietnam is the "Airborne People Sniffer." Out of 575 detections recorded during a month period, 268 were confirmed, resulting in many engagements.

Cited as an example of the success of this device was a series of detections by the 1st Cavalry Division (Airmobile), resulting in a B-52 raid that forced enemy forces to move from hidden positions during the day. Armed helicopter strikes on the moving enemy resulted in further VC casualties.

In pointing to the role that the Defense Supply Association can play in helping the Army to solve some of the difficult problems in Southeast Asia, General Betts stressed dust control and landing zone clearance in helicopter operations, and devices to detect and destroy snares and booby traps in landing areas.

He also explained why the problem of detecting and destroying VC tunnels is difficult, said some success is resulting from use of a ditch digger across suspected areas, and pointed to a "critical need for a lightweight, simple and effective destruction capability."

Among the meaningful advances being provided through R&D to provide the best possible medical care for the wounded in Vietnam, he mentioned the MUST (Medical Unit, Self-contained, Transportable), acclaimed as "providing the finest forward area surgical care of any war."

Advanced Technology Engine Program Pushed

(Continued from page 1)

advanced developmental work on the 1,500-Horsepower Demonstrator Engine Program will design, fabricate and test their respective engines.

Primarily, this advanced technology is the use of higher turbine inlet temperatures (above 2000° F.) and higher compressor pressure ratios which could result in up to a 40 percent reduction in engine weight, lower volume and 25 to 30 percent lower fuel consumption over current engines, AVLABS scientists believe.

"The advanced development program is considered a highly significant one in that it proposes to demonstrate, in an integrated design, a technology base from which engine development to support future aircraft systems development could be initiated," stated John W. White, chief of the AVLABS Propulsion Division.

The AVLABS effort is the first Army Advanced Technology Demonstrator Engine Program and is related, in a still undetermined degree, to the regenerative type engine program and is aimed to improve the 1,500-horsepower-size engine performance to be competitive with engines twice that size or larger.

Nicholas C. Kailos, aerospace engineer in the AVLABS Propulsion Division, is project engineer for the 24-month contracts on the 1,500-hp. demonstrator engine, as well as for the regenerative engine program. Aerospace engineer Edward P Dunn Jr. is assistant engineer.

The configuration of the demonstrator engine required by the RFQ (request for quotation) specifications is for a nonregenerative, front-drive, turbo-shaft engine, including self-contained oil tank and cooling provision.

Flight tests of the AVLABS new T63 regenerative type engine in a light observation helicopter began Aug. 25, 1967, and were still in progress as this publication went to press. The tests are a "first in the world" venture in the advanced developmental aircraft engine program utilizing this type engine in a VTOL aircraft.

A program review was held late in September at Allison Division facilities of General Motors Corp., in Indianapolis, Ind., to give representatives of the aircraft airframe industry and government personnel an opportunity to inspect the T63 engine installation in the LOH and to review flight test results.

Estimates of the fuel economies that may be achieved with the regenerative-type engine range up to 50 pecent, depending upon the level of heat-exchanger (regenerator) effectiveness and specific mission involved.

Other potential advantages are reduced aircraft gross and empty weights, reduced fuel logistical requirements, increased aircraft range capability, and increased payload capability.

Pierce Named DCofS at Huachuca

The U.S. Army Strategic Communications Command has announced appointment of Col Garner T. Pierce as deputy chief of staff, Personnel, Fort Huachuca, Ariz.

Col Pierce was until recently a deputy to the assistant chief of staff for Communications Electronics, U.S. Army Vietnam. He is a graduate of the University of Omaha and earned a master's degree in personnel management from George Washington University.

ASC Slates Panel On Vietnam Needs

(Continued from page 1)

diseases and combat wounds, and the social sciences and human factors problems involved in dealing with the Vietnamese.

U.S. Army Medical Service officers who have served recently in Vietnam will be invited to report on their experiences and observations during the panel discussion, as will officers and civilian advisers who have been concerned with social sciences and human factors aspects of the conflict.

The panel discussion proved highly successful as an innovation at the previous Army Science Conference in 1966. The topic was "Basic Research and Practical Relevancy." Discussion involved eight distinguished leaders representative of academic institutions, industrial organizations, the U.S. Government and the general public.

Throughout Army in-house laboratories and arsenals, prospective authors of technical papers for the conference are preparing summaries that will be reviewed by the individual commands before they are submitted to HQ Department of the Army for consideration of merit.

A total of 110 papers, 96 of which will be presented and 14 of which will be supplementary in case substitutions must be made, will be selected. Normally, about 425 to 450 in-house personnel vie for the honor of being selected by top-ranking Army scientists to present papers.

3-Year Nike-X Savings Total $24.6 Million

Nike-X missile defense system cost reduction experts during the past three years have pinched pennies to the tune of $24.6 million — or, enough dollar bills to pave a highway between Huntsville and Athens, Ala.

Economies achieved in the Nike-X R&D program and some of the ways they were accomplished were announced in conjunction with Cost Reduction Week.

The savings have been validated by the Defense Contract Audit Agency and the U.S. Army Audit Agency. Norman Adams, Nike-X cost reduction coordinator, and six other CR specialists recently received commendations for their work from Col J. T. Prendergast, Director of System Research, Development, Test and Evaluation, for their Nike-X efforts. Five have been recommended for Department of the Army commendations.

They are Jesse A. Westmeyer, Value Engineering Office; Peter C. Andras, Project Field Office at the Martin Marietta Co. in Orlando; Gene S. Gilbertson, Western Electric Co. in Burlington, N.C.,; Teruo T. Hino, McDonnell Douglas in Santa Monica, Calif.; Cecil C. Ogren, Raytheon Co., Bedford, Mass.; and Joseph Unterkofler, Bell Telephone Laboratories in Whippany, N.J.

Adams said the Nike-X project had a cost reduction goal of $5 million in FY 1967. That was topped by $1.4 million. Previous savings were $7.3 million in FY 1966 and $10.9 million in 1965.

Brig Gen I. O. Drewry, Nike-X project manager, has asked that all engaged in the program make cost-consciousness a way of life and look for the most economical ways of performing every job. He has given recognition to industry efforts toward cost reduction through letters of appreciation and in a recent Value Engineering seminar lauded contractors' efforts toward reducing R&D costs.

Examples of CR practices effected by Nike-X system contractors:

ITEM: String saving. In winding Sprint motor cases new balls of roving were used to start each job and this often resulted in unusable lengths being left over. A schedule was set up to establish the exact amount required for each job and the amount of roving on each spool. The spools were matched to the job and a net saving of $115,468 resulted.

ITEM: A tiny paint brush was used to apply epoxy cement to a contact spring for electrical connectors. Excess epoxy had to be removed. A device was acquired which applied a premeasured amount of the cement faster than the older method and without excess. Savings were $17,970.

ITEM: Standard Watlow heaters (water cooled resistors) were used to replace specially designed resistors in a power circuit, saving $92,000.

ITEM: A cast structure for the Spartan missile was designed to replace a number of machined parts, saving $54,504.

ITEM: A VE study resulted in going to a precision plastic molding for a waveguide element with critical tolerances. The one-piece structure saved $105,242.

ITEM: Saving wire is even better than saving string. In the Missile Site Radar 15,000 cables were required to connect the computer to antenna elements and each cable contained four color-coded wires. Replacement of a black ground wire for four different color coded ground wires saved $142,018.

Antiballistic Missile Defense Linked to Army Efforts

(Continued from page 1)

service "in the early 1970's." The $5 billion cost over the entire deployment period does not include R&D, currently costing nearly $500 million annually and expected to continue at about this level.

"The R&D program on ABM components of the Nike-X system, as contrasted to this ABM deployment program, will continue," the Department of Defense stated, "with tests being conducted at Kwajalein.

"Exact nature of the tests and the time schedule for them is classified. Work on ABM component development will include work on the MAR radar, against which our offensive missiles will be tested to help maintain U.S. assured destruction capability."

The system will provide a defense capability against sea-launched missiles, the Defense Department stated, but will not be designed for a large-scale Soviet attack except for the protection of Minuteman sites. Emphasized in response to interrogation was, "there is no plan or intention to expand the system."

Other questions and answers pinpoint system design objectives:

Q. Will it stop a "demonstration" attack by another nation?

A. This depends on what a "demonstration" attack is. If it is small, the answer is yes. But if an enemy wants to "get" one U.S. city, it can do so with this defense or any other by using a saturation attack.

Q. Will it handle an accident?

A. In all probability, yes, assuming the "accident" is a few missiles.

The Army's Spartan missile will engage targets generally outside the earth's atmosphere at several hundred miles range and the Spring is designed to intercept incoming missiles at a range of about 15 to 25 miles. Acceleration of the Sprint is described as "well over 100 g's." Both missiles will be armed with nuclear warheads.

Ground effects of these detonations when intercepts are made will be negligible for blast and radiation, the Defense Department stated, and lethal fallout will not be produced. Volume of fallout will be less than that produced by previous U.S. and Soviet nuclear testing.

Secretary of Defense McNamara's speech announcing the decision to proceed with development and deployment of an ABM defense system oriented against the Communist Chinese attack properly is considered "must reading" for everyone concerned about the thermonuclear warfare threat.

Editors of the *Army R&D Newsmagazine* recognize that many of its readers will have perused every word of that historic speech. For those who may have passed over it once lightly, however, in the urgency of business or personal afairs, a few excerpts follow:

". . .What we sometimes overlook is that every future age of man will be an atomic age. If, then, man is to have a future at all, it will have to be overshadowed with the permanent possibility of thermonuclear holocaust. About that fact, we are no longer free.

"Our freedom in this question consists rather in facing the matter rationally and realistically and discussing actions to minimize the danger. No sane citizen, no sane political leader, no sane nation wants thermonuclear war. But merely not wanting it is not enough.

"We must understand the difference between actions which increase its risk, those which reduce it, and those which, while costly, have little influence one way or another. . . .

"The cornerstone of our strategic policy continues to be to deter deliberate nuclear attack upon the United States, or its allies, by maintaining a highly reliable ability to inflict an unacceptable degree of damage upon any single aggressor, or combination of aggressors, at any time during the course of a strategic nuclear exchange — even after our absorbing a surprise first strike.

"This can be defined as our 'assured destruction capability.' Now it is imperative to understand that assured destruction is the very essence of the whole deterrence concept. We must possess an actual assured destruction capability. And that actual assured destruction capability must also be credible.

"Conceivably, our a sured destruction capability could be actual, without being credible — in which case, it might fail to deter an agressor.

". . .The conclusion, then is clear: if the United States is to deter a nuclear attack on itself or on our allies, it must possess an actual and a credible assured destruction capability. . . .

"That is what deterrence to nuclear aggression means. It means certainty of suicide to the aggressor — not merely to his military forces, but to his society as a whole. . . ."

In defining "first-strike capability" as the power to launch, as an aggressor nation, such a devastating attack as to eliminate substantially the attacked nation's retaliatory second-strike forces, Secretary McNamara emphasized that neither the United States nor the Soviet Union has this capability at present.

"Now, clearly, such a first-strike capability is an important strategic concept. The United States cannot — and will not — ever permit itself to get into the position in which another nation, or combination of nations, would possess such a first-strike capability which could be effectively used against it.

"To get into such a position vis-a-vis any other nation or nations would not only constitute an intolerable threat to our security, but it would obviously remove our ability to deter aggression — both against ourselves and against our allies.

"Now, we are not in that position today — and there is no forseeable danger of our ever getting into that position.

"Our strategic offensive forces are immense: 1,000 Minutemen missile launchers, carefully protected below ground; 41 Polaris submarines, carrying 656 missile launchers — with the majority of these hidden beneath the seas at all times; and about 600 long-range bombers, approximately 40 percent of which are kept always in a high state of alert.

"Our alert forces alone carry more than 2,200 weapons, averaging more than one megaton each. A mere 400 one-megaton weapons, if delivered on the Soviet Union, would be sufficient to destroy over one-third of her population, and one-half of her industry.

"And all of these flexible and highly reliable forces are equipped with devices that insure their penetration of Soviet defenses. . . .

"The blunt fact is, then, that neither the Soviet Union nor the United States can attack the other without being destroyed in retaliation; nor can either of us attain a first-strike capability in the foreseeable future.

"The further fact is that both the Soviet Union and the United States presently possess an actual and credible second-strike capability against one another — and it is precisely this mutual capability that provides us both with the strongest possible motive to avoid a nuclear war.

"The more frequent question that arises in this connection is whether or not the United States possesses nuclear superiority over the Soviet Union. The answer is that we do. But the answer is — like everything else in this matter — technically complex. The complexity arises in part out of what measurement of superiority is most meaningful and realistic. . . .

"What is essential to understand here is that the Soviet Union and the United States mutually influence one another's strategic plans.

"Whatever be their intentions, whatever be our intentions, actions — or even realistically potential actions — on either side relating to the build-up of nuclear forces, be they either offensive or defensive weapons, necessarily trigger reactions on the other side. It is precisely this action-reaction phenomenon that fuels an arms race. . . .

"The fact that the Soviet Union and the United States can mutually destroy one another — regardless of who strikes first — narrows the range of Soviet agression our nuclear forces can effectively deter.

"Even with our nuclear monopoly in the early postwar period, we were

(Continued on page 43)

BRL Camera Records Explosions at Almost Incredible Rate

Eight-tenths of a billionth of a second may be a measurement of time too fleeting for many minds to grasp, but that is the speed at which photographs record physical detonation characteristics of standard military explosives in studies at Aberdeen Proving Ground, Md.

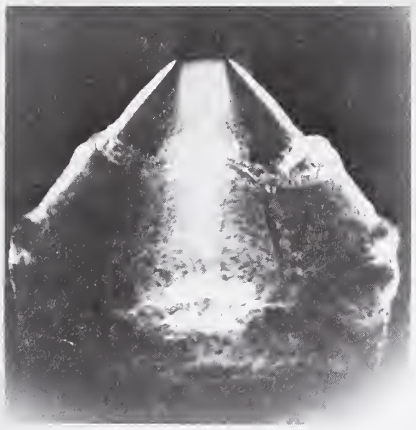
The inventor of the technique of taking photographs at 100,000,000 frames a second is Morton Sultanoff, physicist and chief, Detonation Section, Terminal Ballistic Laboratory, U.S. Army Ballistic Research Laboratories (BRL), an internationally recognized authority on characteristics of explosive research.

The motion picture camera he developed can take up to 300 successive 4- x 4-inch frames at rates from 10,000 to 100,000,000 frames a second with satisfactory resolving power. The ultra-high rates are obtained with a multislit focal plane shutter transported optically across the film plane by a rotating mirror. Framing rates are determined by the selection of slit widths.

A rotating mirror sweeps an image of the slit along the length of the film, recording a narrow segment of the detonation on the film swept in time at rates up to ¼-inch per millionth of a second. The image dissection and sampling technique approaches the Schardin absolute physical limit for the total amount of time-space bits of information which can be recorded by purely mechanical-optical equipment. Experimental studies of the shock and detonation which accompany explosive reactions were for many years hampered by the lack of ultra-high-speed instrumentation, Sultanoff said. Short-duration optical studies are particularly required for investigations of self-luminous explosions and shock waves.

Primary objective of detonation research at the BRL is to provide data that will make explosives more useful in military applications. Through photography, Sultanoff and his associates can observe, among other things, the velocity of explosive waves that move through a charge.

PHYSICIST Morton Sultanoff adjusts explosive flash unit and mirror before TNT charge is detonated in blast chamber at Aberdeen Proving Ground, Md.



30 BILLIONTHS OF A SECOND exposure of a detonating explosive in test.

The image recorded on standard photographic film is the luminosity associated with the detonation at a precise instant. Velocity of the luminous phenomena is derived from the photographic data and by further relating the luminosity to the event. By applying advanced theoretical knowledge, temperatures and pressure parameters can then be inferred.

Used in the experiments are standard explosives such as TNT, PETN, pentolite, composition B, baratol and various types of plastic explosives. Up to 8-pound blocks of explosives are detonated in BRL chambers. Larger charges are exploded on outdoor test sites.

In addition to the camera he developed, Sultanoff also uses an ordinary snapshot camera coupled with a single-exposure electro-optic Kerr-cell shutter and a rotating-mirror streak camera for recording quantitative data. The slower devices help to supplement the data obtained by the Sultanoff camera.

A U.S. Government employe for 27 years, the BRL researcher has been with the laboratory for 21 years. His work in the explosive research field has been recognized by scientific journals in Russia, England, Japan, India, Israel, France and Germany, as well as in the U.S.

He studied mechanical engineering at Drexel Institute of Technology, physics at the University of Delaware and optics at Johns Hopkins University.

He has been guest lecturer at seminars and courses at Massachusetts Institute of Technology, University of California (Los Angeles), University of Wisconsin and Johns Hopkins.

Sultanoff was awarded the E. I. du Pont Gold Medal by the Society of Motion Picture and Television Engineers for outstanding contributions to the science of high-speed photographic instrumentation. He is a permanent member of the International Congress on High-Speed Photography and has presented papers at meetings in Paris, Cologne, The Hague and London and in many U.S. cities.

Sprint Carrier Prototypes Undergoing Tests

Designed for upright transport of the 27-foot-long Sprint antimissile missile, one of two interceptor missiles of the Army's Nike-X system, a 53-foot-long tractor-trailer with a 25-foot-tall tower is undergoing tests.

The first of three prototypes of the carrier, intended for transport of the Sprint from its assembly building to the launching cell, is scheduled to be delivered by Westinghouse Corp. to the Martin Marietta Co., developer of the Sprint, by Dec. 31.

Based on a standard commercial tractor, the vehicle has a special trailer and a track width of 10 feet to allow it to be driven over the launching cell. The Sprint will be lowered into the underground cell through a 9-foot hole in the trailer bed.

The air-conditioned vehicle will house electronic test equipment which can take the Sprint's pulse, once it is in the cell, and tell technicians whether there is any trouble in the missile or in circuits in the cell.

Announcement of details of the vehicle was made by the Army Missile Command Nike-X Project Office at Redstone (Ala.) Arsenal.

AMC Shifts Missile Plant From ATAC to MICOM Control

(Continued from page 1)

tinue their same duties in the same location with the change of plant cognizance to the Missile Command.

The MAMP is occupied by Ling-Temco-Vought (LTV), prime contractor for the Army's Lance missile, and by Chrysler Corp. personnel working on a small project which is expected to be completed at an early date.

The entire facility consists of 29 major buildings and secondary structures occupying a 314-acre tract. Major buildings cover an area of 2,082,683 square feet and secondary structures add 84,540, making a total for all plant buildings of 2,167,223 square feet.

Built in 1953 by the Navy for the manufacture and testing of turbo-jet and turbo-prop engines, the facility was transferred from the Navy to the Army in 1958, with plant cognizance assigned to the Missile Command, and on Jan. 1, 1963, MAMP was reassigned to the them existing Army Mobility Command at Warren. When the Mobility Command was phased out Feb. 1, 1967, the Army Tank Automotive Command assumed plant cognizance.

MUCOM Briefing Lists Needed R&D Advances

(Continued from page 1)

detailed major progress, problem areas, requirements in Southeast Asia, and some Department of Defense future objectives. (For excerpts from his address, see separate article on page 28.)

Maj Gen Frank G. White, MUCOM commander, welcomed the group. He was introduced by Col Irving R. Mollen, head of the RD&E Directorate and coordinator of the briefing.

General White said the purpose is to challenge and stimulate the best of our nation's R&D competence to enable us to solve the increasingly complex scientific and technological problems which are — and will be — facing us in our development programs.

"While our conference is aimed at the 1970-75 time frame, we are also deeply interested in new and novel ideas to help us solve some of the more urgent and current problems we are encountering in Vietnam. They include tunnel destruction, detection of personnel, improved munitions effects in jungle canopies, and warning and detection devices to locate the unseen enemy and to protect against ambush."

Briefing presentations and exhibits, showing some of the meaningful R&D end-products of MUCOM installations in recent years, were representative of Picatinny Arsenal, Dover, N.J., MUCOM HQ; the Defense Development and Engineering Laboratories, and the Weapons Development Engineering Laboratories, Edgewood (Md.) Arsenal; Frankford Arsenal, Philadelphia, Pa.; Fort Detrick, Md.; and Harry Diamond Laboratories, Washington, D.C.

"MUCOM RD&E Organization and Program" was discussed by C. H. Staley, chairman of the opening session and technical director, RD&E Directorate. Col O. D. Moore, head of the MUCOM Procurement and Production Directorate was programed to follow with "Contractor Opportunities in Army Munitions. Robert Howie, MUCOM Army/industry liaison officer, subbed for him. Due to illness of W. R. Carson, chief, Ammunition Division, RD&E Directorate, the session on "Conventional Ammunition" was presided over by Abe Dorfman, technical assistant to the commander of Picatinny Arsenal.

Scientists of Picatinny and Frankford Arsenals reported on their investigations and the opportunities for industrial assistance on future weapon systems, tube-fired munitions, nonnuclear missile/rocket warheads, explosives, propellants, pyrotechnics/chemiluminescense, small-caliber ammunition, caseless ammunition, and consumable-combustible cartridge cases.

Dr. S. D. Silver, director, Research Laboratories, Edgewood Arsenal, and Dr. John Erway, chief, Research Division, RD&E Directorate, MUCOM, presided as session chairman second-day opening.

Col R. L. Andreoli, director, Weapons Development Engineering Laboratories at Edgewood, gave the introduction to the Army chemical program, and also discussed chemical weapons. Topics included chemical weapons and chemical defense measures.

Dr. Erway presided over presentations by Picatinny and Frankford researchers on propellant-actuated devices, ammunition packaging, special connective devices, automation for manufacture of ammunition, mines and demolitions, and special warfare.

In the afternoon sessions, W. Benson, chief of the Engineering Sciences Laboratory at Picatinny Arsenal, presided over a discussion that included inertial fuzing, mechanical time freezing, electronic timers and programers, proximity fuzing, and fluerics. Frankford Arsenal and Harry Diamond Laboratories employes made the presentations.

The biological session chairman was Dr. Riley D. Housewright, technical director at Fort Detrick, Md., and the summary was made by Col P. G. Olenchuk, commander of the installation. All presentations were by Detrick personnel. Topics included biological agent development and production, biolgical weapon systems, biological defense systems, and improved defoliant-herbicides.

MUCOM Chief Scientist Dr. J. V. R. Kaufman made the closing comments.

Dignitaries at the banquet head table, in addition to Dr. Larsen and General White, included Chief Chaplain (Col) Richard W. Jungfers, U.S. Army Materiel Command; Vice Adm Joseph F. Lyle (USN, Ret.), NSIA president; Capt Robert N. McFarlane (USN, Ret.), NSIA past president; Carroll Staley, technical director, RD&E Directorate, and MUCOM general chairman for the briefing; and

Maj Gen Gordon W. Austin (USAF, Ret.), NSIA director of national activities; Maj Gen Richard H. Free, U.S. Army Materiel Command Director of Development; Maj Gen Lloyd Fellenz (USA, Ret.), former director, CBR and Nuclear Operations, Office, Assistant Chief of Staff for Force Development; Maj Gen John Zierdt (USA, Ret.), former CG, U.S. Army Missile Command; and

Brig Gen James A. Hebbeler, Director, CBR and Nuclear Operations,

(Continued on page 23)

WECOM To Conduct Briefing On Advanced R&D Planning

The U.S. Army Weapons Command will conduct a day-long Research and Development Advanced Planning Briefing for Industry Oct. 26.

Brig Gen W. J. Durrenberger, AWC commanding general, announced that the third annual classified briefing will be cosponsored by the Army Weapons Command and the American Ordnance Association. More than 400 invited industrial executives from throughout the country are expected to attend.

The AWC has responsibility for R&D and design of weapons and logistic support, including helicopter and other aircraft armament currently in use in Vietnam, rifles, machineguns, grenade launchers, tanks and other combat vehicles, artillery, mortars, recoilless rifles, aiming and firing controls and various items of support equipment. Weapons are also supplied to the Marine Corps, Air Force and various allied nations.

ECOM Adviser Blends Patents, Pulchritude

Pulchritude and patents are closely linked at the U.S. Army Electronics Command Patent Agency, Fort Monmouth, N.J., where Mrs. Rosemary Ryan, tall, slender and attractive blonde, is the first lady adviser in the agency's 25-year history.

Mrs. Ryan is the most recent addition to the select group of 12 men who in similar patent duties are responsible for protecting the government's rights in inventions made by ECOM personnel or derived from ECOM's contractors. In this case, the men seem to think good luck is associated with the number 13.

Mrs. Ryan's patent adviser duties will be centered in the electronics field, in which she is well qualified by education and experience.

Rosemary Ryan

Previously, she worked as an electronic engineer in the command's Engineering Support Services Department. Her duties involved monitoring contracts and performing exploratory work in the field of improved communications through reduction of material and man-made interference.

Mrs. Ryan has been a staff member of the Hughes Aircraft Corp. in Culver City, Calif., and the Raytheon Co., Sudbury, Mass. She worked on the documentation for digital testing systems at the latter firm.

A 1962 graduate in electrical engineering from Pratt Institute, Brooklyn, she also attended the Seton Hall University School of Law and plans to continue her law studies in the evening school.

Mrs. Ryan is a native of New York City and has a 4-year-old daughter.

Brig Gen Terry Designated CG of STRATCOM-Pacific

Brig Gen Robert B. Terry, now CG of the U.S. Army Strategic Communications Command (STRATCOM) Pacific, was among the officers assigned to the Office of the Chief of Research and Development when it was established in 1955.

His new assignment follows a tour as CG of the STRATCOM 1st Signal Brigade, Southeast Asia, since April 1966. Under his command, the Brigade expanded from 7,000 to 19,000 men, making it the largest theater communications organization in the Army. Until assigned to Vietnam, he was chief of staff, U.S. Army Electronics Command, Fort Monmouth, N.J.

Headquartered at Schofield Barracks, Hawaii, General Terry will have command responsibility for engineering, operation and maintenance of the Army's communication systems throughout the Pacific Theater. He will serve also as assistant chief of staff, Communications-Electronics, U.S. Army Pacific.

As one of STRATCOM's five major commands, STRATCOM-Pacific accomplishes its missions through Signal Groups in Hawaii, Korea, Japan, Okinawa and Taiwan.

Brig Gen R. B. Terry

General Terry is a 1942 graduate of the U.S. Military Academy and holds a master's degree in communication engineering from the University of Illinois (1947). He has completed the Command and General Staff College (1955), the senior course at the Naval War College (1959), and has served as an associate professor of electricity at the U.S. Military Academy. During World War II, he served with the 6th and 13th Armored Divisions and the XXII Corps. He later served in the South Pacific Theater; with the Alaska Communications System; and in Paris, France, with the Office of the Defense Representative, North Atlantic and Mediterranean Areas.

In 1965, he participated as J-6, Communications-Electronics, U.S. Forces, Dominican Republic.

Col Bush Designated to Direct ECOM's Materiel Management

The U.S. Army Electronics Command (ECOM), Fort Monmouth, N.J., has assigned Col Sydney A. Bush as director, Materiel Management, Philadelphia, Pa.

Col Bush was assigned previously to HQ, U.S. Army Pacific as logistics officer, then as chief, Electronics Materiel Division, and recently as special assistant to the director of Supply and Maintenance. Other assignments have given him experience in logistics and supply at major U.S. depots as well as overseas.

Prior to the USARPAC tour, he was commander of the 4th Signal Supply and Maintenance Battalion and the 8th U.S. Army Signal Depot in Korea. For four years he was on the Department of the Army General Staff, Office of the Deputy Chief of Staff for Logistics, as program manager for Communications and Electronics (PEMA).

Chief of R&D Names Col Rafert Assistant Developments Director

Col Walter E. Rafert, who was chief of the Combat Arms Branch, Combat Materiel Division since coming to the Office of the Chief of Research and Development in the summer of 1966, has been named Assistant Director of Developments, OCRD.

He succeeds Col T. W. Mellen, who held the position under the title of Deputy Director of Developments. Col Mellen is now Director of Developments.

Col Rafert graduated from the Army War College in 1966, following duty in the Long-Range Technical Plans Branch, Research and Development Directorate, Army Materiel Command. He has served in England and Taiwan and has instructed at the Army Ordnance School and U.S. Military Academy.

He holds a BSME degree from Purdue University, and an MSME and a degree of engineering (mechanical engineering) from Stanford University.

STRATCOM FLAG passes from Col Blaine O. Vogt (left) to Brig Gen Hugh F. Foster Jr. during change-of-command ceremonies at Fort Monmouth, N.J., headquarters of the Army Communications Systems Agency (ACSA). A Universal Integrated Communications (UNICOM/STARCOM) and the former European Tropospheric-Army (ET-A) are two of the basic elements in the ACSA. General Foster returned this summer from Korea, where he served since leaving his earlier Fort Monmouth post as project manager of UNICOM/STARCOM in 1963. Col Vogt, now assigned to Vietnam, commanded the ACSA since its establishment in March. ACSA is a combined Strategic Communications Command agency and Army Materiel Command Project.

AOA to Discuss CBR At Classified Session

The Chemical, Biological and Nuclear Division of the American Ordnance Association has scheduled its classified annual meeting, Nov. 2-3, at Andrews Air Force Base, Suitland, Md.

The theme is "CBR Research and Development Programs Needing Industry Support" and distinguished members of the Department of Defense and the Military Departments will make presentations.

Army agencies that will be represented by speakers include the Chemical, Biological and Nuclear Directorate of the Office of the Chief of Research and Development; Edgewood (Md.) Arsenal; Fort Detrick, Md., and Deseret (Utah) Test Center.

Friday afternoon, Nov. 3, will be devoted to seminars on biological weapons systems, chemical weapons systems, chemical and biological defense systems, logistics and value engineering.

The Amos A. Fries Gold Medal, awarded annually for outstanding contribution to chemical warfare, will be presented at the Thursday evening banquet at the Andrews Air Force Base Officers' Open Mess.

A SECRET security clearance is necessary for attendance. For further information and agenda, contact Col Norman I. Shapira (USA, Ret.), Litton Industries, 1875 Connecticut Ave., N.W., Washington, D.C. 20009 Tel. (202) 462-8833.

Field Anesthesia Units Shipped to S. Vietnam

U.S Army medical care in the field has advanced another step with delivery of 10 new compact anesthetic supply cases to join MUST hospital units and field anesthesia machines in South Vietnam.

The "Field Anesthesia Chest," an item long needed to hold all the vital supplies of anesthetists, physicians and nurses in one accessible place, weighs about 110 pounds fully packed.

Containing more than 100 line items, the chest is issued as a "depot pack" with liquids, freezables and deteriorating items in drawer six for quick identification and removal if indicated.

Frank Corbett of the Medical Engineering Research Laboratory, Fort Totten, N.Y., headed a team effort with nurses and doctors at Walter Reed Army Medical Center, Washington, D.C., which produced "a superior item" and an idea for a whole family of chests for the MUST concept.

The cover of the chest may be used as a table top, thus giving the user a compact dispensing cabinet and table. MUST (Medical Unit, Selfcontained Transportable) has been in the field for more than a year and was joined by the Army's first man-portable field X-ray unit this year.

ASA (R&D) Discusses Importance of Project Management

Assistant Secretary of the Army (R&D) Dr. Russell D. O'Neal discussed the vital role of R&D project managers in a Sept. 14 address to the graduating class of the Defense Weapons Systems Management Center, Wright-Patterson Air Force Base.

"The quality of our program managers," he said, "is the single most important factor in the success of our weapon system acquisition process."

Program management was termed a relatively new and rapidly developing science, as distinguished from the time-honored "bull of the woods" concept of industrial management.

Emergence of effective labor organizations within recent years has made it increasingly important to define more precisely the functions of each employe, Dr. O'Neal emphasized.

In commenting on growth of science and engineering since World War II, he quoted from an article by Paul O. Gaddis, "The Age of Massive Engineering," published in the *Harvard Business Review*, January-February issue, 1961.

"We are no longer in the Age of Mass Production; rather, we are in the Age of Massive Engineering. Now recently developed knowledge is being massively used to determine specific solutions to new problems in all fields. This is not to say that mass production will no longer be the keystone to our material prosperity. But it does strongly suggest that it is time to concentrate our resources on the management frontier where problems are profound and management knowledge is all too limited."

System engineering techniques have been developed to handle the complexity of many of the nation's large systems, Dr. O'Neal said, but he was of the opinion that "despite its extreme importance, less progress has been made on the management side.

"Management theorists have not been of much help in solving the new and unique problems which massive engineering, and especially systems engineering, have posed to American government and industry. Managers of system design, therefore, have had to develop their own approach — the project system — and hence project or program managers."

Dr. O'Neal said that 10 to 15 years ago he believed that a matrix organization, in industry at least, with most of the strength being in the functional departments, was the best way to operate. Now he favors "putting more complete authority in the hands of the program manager and giving him resources and authority more commensurate with responsibility he carries."

Referring to an Air Force Systems Command study several years ago of a large number of programs to determine what types of management best served the weapons systems acquisition process, he commented:

"One of the most important conclusions from this study was that in most cases the most successful programs were those in which there was a single-point responsibility and the program manager was given the resources and authority directly over all elements of the project."

Because of this great increase in responsibility, he said, it has become critically important to select the best obtainable talent in assigning project managers.

Dr. O'Neal then turned to a discussion of his "strong belief," as gained from experience and observations, of how a program manager must learn to operate for maximum effectiveness, as follows:

"First, lay out the program in measurable program milestones. I think one of the most important things in the initiation of any program is the laying out of the master schedule so that you can have frequent checks on how well the program is progressing. I know you have heard this many times. It sounds so logical, yet is so difficult to do really well.

"I believe the two most important prerequisites to laying out a meaningful master schedule are: (1) a thorough understanding of the user's requirements—and I don't mean a stylized formal statement of requirements — but an intimate knowledge of what the user really needs; and (2) a fundamental understanding of the system to be developed, produced, and deployed.

"I can't overemphasize the importance of developing this understanding. Too often people become more engrossed in the techniques of management than in understanding what they are managing. I call it management with a capital "M," or management for management's sake.

"It is sometimes said that a good manager can manage anything, as though it were not important to understand the system he is managing. It has been my experience that the good manager really digs in to understand in detail what he has to accomplish.

"The logical milestones, of course, are different for different kinds of weapons systems. If you lack experience in a particular type of weapons system, be sure to get good advice from experienced

TECOM Picks 2 as APG Materiel Test Directors

U.S. Army Test and Evaluation Command assignments recently moved Col Raymond F. Johnson to director of Aviation Materiel Testing, and Col John P. Wheeler to director of Armor Materiel Testing at Aberdeen Proving Ground, Md.

A Master Army Aviator with more than 6,000 hours flying time, Col Johnson is responsible for directing test and evaluation of aircraft, aircraft components and navigation aids, and ground support equipment. He was assigned to Aberdeen after duty at Fort Rucker, Ala., as G3 of the Army Aviation Center, followed by service as deputy president and president of the Army Aviation Test Board. During an earlier tour, he directed rotary wing training at the Army Aviation School, then commanded a Corporal missile battalion at Fort Sill, Okla., and was assigned to Vietnam in 1962.

Commissioned in the Field Artillery Reserve in 1940, he participated in the Rhineland and Central Europe campaigns of World War II with the 416th Artillery Group, 90th Infantry Division Artillery and the 4th Armored Division. Col Johnson is a 1957 graduate of the Command and General Staff College and holds a BA degree in history and political science from California Western University, San Diego.

COL WHEELER recently completed a 2-year tour in Southeast Asia with the Joint U.S. Military Advisory Group in Thailand.

Col J. P. Wheeler

Commissioned in the Infantry when graduated from the U.S. Military Academy, he served with the 9th Armored Division in the U.S. and Europe during World War II, participating in the Rhineland, Ardennes-Alsace and Central Europe campaigns.

Col R. E. Johnson

Postwar assignments included duty with the staff and faculty of the Ground General School at Fort Riley, Kans., and three years with the 57th Medium Tank Battalion in Texas and Europe. He served in the Office of the Assistant Chief of Staff, Intelligence, in Washington, D.C., from 1955 to 1958 and then was sent to Korea as G3, I Corps.

Assigned to the U.S. Continental Army Command in 1959, he served three years at Fort Monroe, Va., as research and development coordinator, Communications and Electronics Division, Office of the Deputy Chief of Staff for Materiel Development.

At Fort Riley from 1962 to 1965, he commanded medium tank battalions of the 63d and 69th Armor and was G3 of the 1st Infantry Division until assigned to Thailand in 1965.

people, both on the user side of the house and on the development side of the house, before generating or approving your master schedule. . . .

"Use all the help you can get. If you come late into a program and find that the milestones don't make sense, work on them until they do. No program is so complex that you can't make a logical, fairly easily understood, master schedule with proper milestones. I think some program managers become so enamoured with tools such at PERT, computer run-outs, etc. that they miss the larger overall system picture.

"A detail in laying out your program — but one which I feel is particularly important — is to make sure you provide for sufficient simulation and ground environmental testing. Our missile programs have shown us the importance of computer simulation in early design, detailed design, and in checking flight test results against prediction. Our space programs have shown us the importance of very extensive and comprehensive ground environmental tests

"Because of the expense of each flight, and therefore the great importance of having complete success in the first or at least the very early flights of a program, we have learned to make maximum use of thermal vacuum facilities, vibration facilities and wind tunnels, in order to test on the ground subsystems and, where possible, complete systems very thoroughly.

"One can go a long way in finding the problems and ensuring reliable equipment by extensive ground tests carried out under rigorous yet controlled conditions.

"A third point is to define carefully your interfaces, internally in the program as well as externally. The latter, of course, is particularly important in laying out your milestones. I have observed some rather serious problems, particularly in programs where there is a large amount of government-furnished equipment, and this, of course, is often the case.

"The program manager unquestionably has responsibility for the total program, and if the program slips he gets blamed. He may have very good control of his prime contractor, but he can get into real trouble if he doesn't have just as good control over the government-furnished equipment.

"Sometimes this is difficult to accomplish because of the way in which government organizations are set up. However, the problem must be recognized and the proper interfacing responsibilities established and progress measured if the program is to be successful.

"A fourth point is that a program manager should be flexible in his attitude towards carrying out the program. You want to try to have your own organization and the contractor's organization set up as ideally as possible, but you won't ever achieve the ultimate. You will always have to live with certain compromises.

"If you can't change the system, work around it and lay your program out so that you can measure success or failure in key areas where you fear problems.

"You will have many problems, even in the best-run program. Anticipate them. Have your program set up and know what progress is being made so you know that you have a problem before it becomes so serious as to jeopardize performance, schedule, or cost, or maybe all three.

"It is true that you can get a job done with what is unorthodox and what you may consider poor organization. For instance, I was shocked about nine years ago to find that a major organization with which I wanted to team on a program had no formal organization chart — yet that organization had produced very excellent aircraft and had a very fine reputation.

"All I am saying is, try to set things up by the book as much as possible, but don't be too concerned if some parts of it are unorthodox — just watch those parts with an eagle eye.

"A fifth point is that a program manager must be flexible in his internal program scheduling. You will run into unexpected problems which will cause internal readjustments of schedule to keep your overall project on schedule. PERT is an important aid in doing this and, of course, was designed as a tool to help in just this sort of situation.

"Much of the success of a program depends upon the skill with which a program manager can readjust his schedules and his resources so as to keep the overall program moving along towards the end schedule objective.

"A most important "don't" is — Don't hold your problem too close to your chest. I have seen more mistakes made by program managers for this one reason than any other. It is human nature on the part of all of us to hesitate to expose a problem, hoping that we will be able to solve it before anyone higher in the organization finds out about it.

"It is always embarrassing to have to admit one has a problem, but the cardinal sin is to not disclose it, and, if necessary, ask for help before it is too late to handle it without major detriment to the program.

"A sixth point is that a program manager must communicate with many people clearly and concisely, both verbally and in writing. I can't overemphasize importance of good communications.

(Continued on page 10)

AMC Chief Engineer Retires With Top Award

Assistant Secretary of the Army (R&D) Dr. Russell D. O'Neal presented the Army's highest civilian decoration to the Army Materiel Command's chief engineer, Charles H. Zimmerman, upon his retirement Aug. 1.

The Exceptional Civilian Service Award capped 26 years of government employment for Zimmerman, a member of the U.S. Army Scientific Advisory Panel from 1956 to 1963. Before going to AMC, he was director of aeronautical research for the National Aeronautics and Space Administration (1962-63).

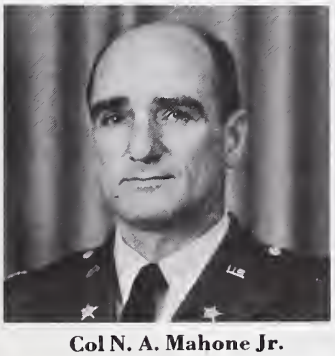
Upon his graduation from the University of Kansas in 1929, he worked for the Langley Laboratory of the National Advisory Committee for Aeronautics. There he developed the NACA free-spinning wind tunnel and the free-flight wind tunnel.

In 1937, he was employed by the United Aircraft Corp. as supervisor of the design and development of the V-173 and XF5U- flying wing V/STOL aircraft. In 1948, he returned to the Langley Laboratory of the NACA and was a leader in research on V/STOL aircraft until 1962.

He holds a master's degree in aeronautical engineering from the University of Virginia. In 1956 he was given the Alexander Klemin Award of the American Helicopter Society and the Wright Brothers Medal of the Society of Automotive Engineers. His successor had not been announced at press time.

Career R&D Specialist Chosen Cayuse Project Manager

The newly appointed project manager for the Army's Cayuse (OH-6A) light observation helicopter is Col Nelson A. Mahone Jr., a veteran of the Army R&D Officer Specialist Program who recently served with the 1st Cavalry Division (Airmobile) in Vietnam. A Master Army Aviator, rated in both fixed and rotary-wing aircraft, Col Mahone served as chief of Army Aircraft R&D Branch, Air Mobility Division, Office of the Chief of Research and Development, Department of the Army, from July 1961 to April 1964.



Col N. A. Mahone Jr.

He served with American combat forces in the European Theater of Operations during World War II and with the 25th Artillery in the Korean War. In recent years, he has served as a battalion commander with the 377th Aerial Rocket Artillery of the 11th Assault Division and with the Aviation Test Board of the U.S. Continental Army

The colonel is a 1943 graduate of Virginia Military Institute. He took graduate courses in aeronautical engineering at Princeton University (1950-52) and is a graduate of the Command and General Staff College, and National War College.

ASA (R&D) Discusses Project Management

(Continued from page 9)

"Communications, of course, means not only that a message has been transmitted, but also that it has been 'received.' Too often, we all think that simply because we said something it was understood by the person hearing it. I have seen many things go wrong, sometimes in important programs, because there was not a complete communication of what was to be accomplished.

"General Besson, commander of the U.S. Army Materiel Command, has said that project management, in sum, represents *our* solution to *our* problem — the problem of communicating the decisions of top management on major projects and programs down to the operating level, and for communicating upwards the results and effectiveness of the operation.

"We could go on and on like this, but it all adds up to the fact that a program manager must have the wisdom of Solomon and the patience of Job. Above all, he must be a leader. Although he has great authority, often over large organizations and many, many people, just ordering that things be done is usually not sufficient.

"The program manager's own organization must be inspired to excellence, and this spirit infused throughout the program. As you know, in the final analysis you depend on people to get things done.

"You must arrange things so people can work effectively. It is sometimes helpful to think of yourself as a symphony orchestra conductor directing many diverse capabilities so that all the individual players perform in harmony with each other and with you, to produce a pleasing, well-integrated job — and hopefully you will all conclude the symphony at the same time.

"The program manager must carry many details in his head and must make decisions promptly, often with less data than he would like. He almost always must do the job with fewer people and with less resources than he feels he needs. Don't be afraid to innovate. After all, project management is a new art trying to become a science.

"We still have a lot to learn. For instance, you can very often get valuable help by using ad hoc groups or tiger teams — the ad hoc group make-up of government in-house laboratory people and/or outside consultants to give you a fresh, independent view and to advise you on particular problems — tiger teams to move in on a knotty problem to solve it.

"The program management concept has really proven itself to be most valuable. It is used not only for major system development, but is being used on smaller programs where there is a high degree of urgency and visibility. There are many examples of how it has helped us to get faster action in solving problems associated with the conflict in Vietnam.

"There is no question but what the program manager's life is a tough one but also a most exciting one. He is in the limelight and he is key to success of his program. But the rewards of seeing a job through successfully are great, at least in terms of personal satisfaction, and I believe it offers the best of training for overall management."

Col Ray Takes Command of Picatinny Arsenal

Col Roger Ray took command of Picatinny Arsenal, Dover, N.J., Oct. 2, relieving Col Joseph Capuano from temporary duty following the Aug. 31 retirement of Col John S. Chambers Jr. after 29 years military service.

Col Ray served at Picatinny from 1958 to 1961 as director of the Feltman Research Laboratories. Until recently, he headed a planning group with the Office of the Secretary of Defense, Washington, D.C., where he has held a series of special assignments in recent years.

During four years as a staff member of the Atomic Energy Commission's Los Alamos (N. Mex.) Scientific Laboratory, he participated in scientific experiments at Eniwetok, Bikini and Nevada test sites.

Col Roger Ray

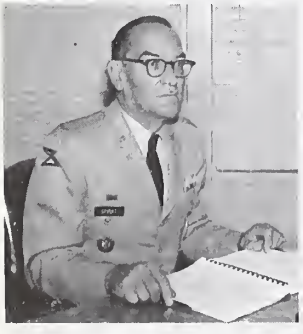
Graduated from the United States Military Academy in 1943, he served in World War II as an Infantry platoon leader in Normandy and later as an intelligence officer with the First United States Army. He earned a master's degree in aeronautical engineering in 1948 from the College of Engineering, New York University.

Transferring to Artillery in 1950, he attended the Artillery Officers Advanced Course in 1953, and was transferred to the Ordnance Corps in 1958.

Col Ray has graduated from the Command and General Staff College and the Industrial College of the Armed Forces. His service career has been recognized by award of the Legion of Merit with Oak Leaf Cluster, Bronze Star with V award and OLC, the Combat Infantryman Badge and the Purple Heart.

Covert Named Manager of Redeye Missile System

Management of the Army's Redeye guided missile system has been assigned to Col John R. M. Covert, who is stationed at Redstone Arsenal, Ala., following a tour as chief, Artillery Branch, Office, DCS for Operations, U.S. Army Europe.



Col John R. M. Covert

Now in production, Redeye is the smallest guided missile designed for defense against low-flying aircraft. In "torture" tests in the arctic and in other extreme environments, it has scored hits on a variety of target aircraft, including unmanned jet fighter planes.

Col Covert received a BS degree in chemistry from the University of California at Berkeley, did graduate work at the University of Michigan, and earned an MS degree in electrical engineering from Pennsylvania U.

A graduate of the Command and General Staff College and the Industrial College of the Armed Forces, he holds the Army Commendation Medal with two Oak Leaf Clusters and the Joint Service Commendation Medal. He has served in a variety of assignments in the U.S., Europe and Okinawa.

MICOM Testing 4 Magnetrons For Hercules Missile System

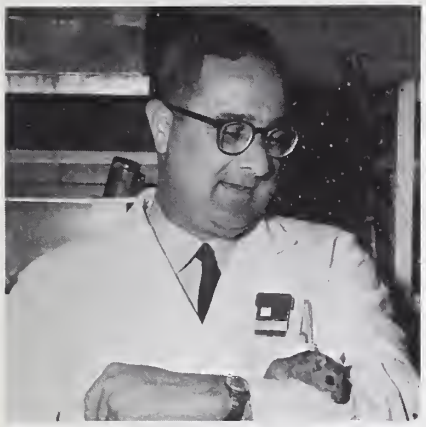
In-house laboratory testing of four types of magnetrons used in the Hercules missile system is being initiated by the U.S. Army Missile Command at Redstone (Ala.) Arsenal.

Testing formerly performed by the Western Electric Co. will soon be performed by the MICOM Procurement and Production Directorate. The major objectives of the change are to qualify potential competitive producers of magnetrons and so insure quality by testing production units.

Western Electric Co., until recently the only company producing magnetrons for the Hercules system, is shipping high-power test equipment to MICOM. Although field testing is essential, laboratory testing has several advantages, including greater flexibility in varying power inputs-outputs for more intensive testing. Field testing of the Hercules magnetrons is conducted at the Air Defense Artillery School, Fort Bliss, Tex.

The magnetron is a high-energy oscillator which converts high-voltage direct current into high-frequency radiated power for radar transmitters.

AFIP Using African Rat as Lab Species



AFIP Radiation Pathology Branch Chief Lt Col David C. White displays African white-tailed rat introduced as the longest-lived rodent laboratory species now used in the United States.

African white-tailed rats *(Mystromys albicaudatus)* have made their debut on the stage of scientific research in the Radiation Pathology Branch of the Armed Forces Institute of Pathology (AFIP).

Lt Col David C. White, U.S. Army Medical Corps, chief of the Radiation Pathology Branch, announced the successful introduction of the animal as a laboratory species in the United States.

The rodent was first imported to this country in 1963 by Dr. Chapman H. Binford, chief of the AFIP Mycrobacterial Diseases Branch, for use in the study of leprosy bacillus. Since that time, the colony has generated about 3,000 mystromys for use in research and dissemination as a breeding stock to other laboratories.

Gaining widespread acceptance by researchers, the African species has an extroadinarily long life span for a small rodent of over six years, making it a suitable model for long-term studies formerly restricted to larger animals.

Mystromys are not susceptible to chronic murine pneumonia, an affliction often found in white rats. The colony at AFIP is free of parasitism, neoplasia, and endemic pathologic conditions observed routinely in post mortem examinations. In general, the mystromys has proved to be a very hardy research animal.

The mystromys presents no special problems of care and feeding, as it is well adapted to the cage environment and eats commercial laboratory diets as its only source of food.

This rat is a regular breeder in the caged environment. The AFIP colony has 10 females who have given birth to at least 20 litters apiece since 1964. A litter averages 3.8 young.

Mystromys have been used in such diverse projects as pathogenesis of dental caries, serum monoamine oxidase enzyme determinations, chronic drug toxicity analyses, investigation of sodium, cesium and iridium retention, reproductive physiology studies, and an examination of the effects of air blast on the lungs.

Several laboratories are also working to establish normal physiological parameters for the species, so that mystromys may have even broader use in biological research.

Members of the Radiation Pathology Branch published an article on the species this year in *Laboratory Animal Care,* a professional journal.

Picatinny Arsenal Co-Op Education Pays Off

Promotion from Civil Service rating GS-3 to GS-14 over a 12-year period, almost half of it in part-time employment while enrolled in educational courses for an engineering degree, is the success story of George McCoy at Picatinny Arsenal.

One of many thousands of outstanding examples of results of the College Cooperative Engineering Training Program (CCETP), McCoy has earned two sustained superior performance awards and a quality salary increase since he became a full-time employe. His BS degree in mechanical engineering is from Northeastern University.

Picatinny Arsenal initiated its participation in the CCETP in 1955 with the hiring of McCoy. Arrangements were made with Northeastern University, Drexel Institute of Technology, and Georgia Institute of Technology to enable part-time employes to continue their education.

Other colleges and universities that have a 5-year CCETP have since joined in cooperating with the Arsenal. Among these are the University of Alabama, Auburn University, Mississippi State, Cleveland State University, Virginia Tech, University of Cincinnati and University of Southern Florida.

Current estimates set enrollment in similar cooperative education programs at about 30,000 students in some 60 colleges and universities. Although engineering students are predominant in such programs, others earn degrees in the sciences, business administration and education.

The CCETP had its beginning in 1906 at the University of Cincinnati with an initial enrollment of 27 engineering students. A 2-year study of the cooperative education program has shown that it increases the motivation of students, broadens their experience and understanding of the relationship between theory and practice.

Army employes presently enrolled in the CCETP are representative of 33 installations. Frankford Arsenal, Philadelphia, Pa., was the first Army research and development activity to start the program as a means of training engineers, and arrangements were made with Drexel Institute. Currently, the largest program is at White Sands Missile Range in cooperation with New Mexico State University.

Supervisors agree that the CCETP has produced excellent results at Picatinny Arsenal in meeting requirements for engineers who are well-grounded in practical requirements of their profession when they graduate.

Candidates in the program are given noncompetitive appointments without taking a written Civil Service test. Upon successful completion of CCETP training, they are eligible for career or career-conditional appointments to professional positions.

Picatinny Arsenal presently employs 19 CCETP students and plans eventually to expand the program to about 50 students. While George McCoy deserves recognition as the first and certainly an outstanding product of the program, other valuable engineering graduates at Picatinny include Kenneth Henrich, chemical; Gary Bubb and Charles Okun, mechanical; William Williver and Alfred Franz, electrical; Robert Drake and Jan Helbers, electronics.

George McCoy

Natick Scientist Authors Book On Cell Metabolism Models

Use of computer techniques to analyze mathematically the metabolism and regulatory mechanisms of cellular systems is described in a new book by Dr. Ferdinand Heinmetz, Pioneering Research Division, U.S. Army Natick (Mass.) Laboratories.

Analysis of Normal and Abnormal Cell Growth deals with model-system formulations and analog computer studies. Published recently by Plenum Press, New York, the book is reviewed in *Science,* the periodical for the Association for the Advancement of Science, Volume 157, No. 3788.

As described, the processes, including enzyme synthesis, are formulated mathmetically in 19 simultaneous different equations of kinetics, involving the laborious task of determining 31 rate constants.

Mathematical processes corresponding to injury or death are studied, along with malignancy, cell alteration during aging, drug reaction, and radiation effects. Researchers believe results of such studies may provide a basis for therapy for various cellular abnormalities.

Heinmet's book is considered "of great importance" in that it may stimulate more biologists to use the computer to study problems that interest them. From a multiplicity of individual results, it is considered feasible to formulate a montage understanding of living things.

ARO-D Publishes Significant Basic Research Results

Twenty-one scientific studies that have produced results considered of broad interest for potential applications of discoveries are reported in "Scientific Accomplishments in Basic Research Supported by the U.S. Army Research Office-Durham During FY 1967," distributed recently to selected government agencies.

In a foreward to the pamphlet, ARO-D Chief Scientist Dr. John W. Dawson states its purpose as follows:

". . .While it is clearly evident that basic research is primarily directed toward the long-range evolution of new knowledge and a more complete understanding of natural phenomena, nevertheless many of the results relevant to the interests of the U.S. Army can be recognized in a relatively short time and can be made available to applied research laboratories for programmatic studies leading to new and novel processes and material."

The highly condensed reports of results in the 21 studies are indexed under the five ARO-D divisions of Chemistry, Engineering Sciences, Mathematics, Metallurgy and Ceramics, and Physics.

In the field of lasers, for example, results of investigations by a team at Massachusetts Institute of Technology on "Ultrasonic Tuning of the Laser" are reported, along with the work of International Business Machines researchers on "Incoherent Pump for Organic Dye Laser."

Under the direction of Prof. G. A. Pratt, the MIT team achieved frequency modulation of a gallium arsenide laser by varying the index of the refraction of the GaAs by means of an ultrasonic sound wave. The ARO-D report states:

"This represents the first successful frequency modulation of a solid-state laser in which the modulation was imposed within the lasing medium itself rather than on the emitted beam. A patent has been applied for by MIT concerning this work."

The series of successes by the MIT team in this investigation dates back to 1963 when Prof. Pratt published a paper in *Physical Review Letters* 11,538. Experiments also have been performed by the Lincoln Laboratory and by Harvard University groups, demonstrating continuous pressure tuning from 8.5 microns to 20 microns.

"The way is now open," the ARO-D report states, "for applied research leading to the development of a relatively simple communication system with a large information rate capacity which is secure in the sense that a message cannot be intercepted at any point far from the line of sight from the transmitter to the receiver."

Another advantage cited over conventional amplitude modulation of a GaAs laser is that modulation is expected to be "much less susceptible to atmospheric turbulence."

Research findings on the "Incoherent Pump for Organic Dye Laser" are reported by the IBM team of Drs. P. P. Sorokin and Gerald Burns. The pumping was accomplished with a fast flashlamp as the first example of true organic optically excited lasers." A number of dyes were stimulated successfully with a specially designed lamp with a pulse width of about 0.8 microseconds and a peak intensity of 0.3 microseconds.

Regarding significance of the technique for various applications, the ARO-D report states:

"It thus appears that the last major obstacle has been removed for the development of organic lasers of extremely intense and narrow beams of light at a variety of wavelengths. Although high-power lasers already exist, notably the well-know ruby, they operate at very selected wavelengths.

"In order to optimize atmospheric transmission and to prevent countermeasures in military applications, it is important to have different frequencies available."

In the Chemistry Division, results of five scientific accomplishments are described. "Research in Fluorine Chemistry" by John Margrove of Rice University tells about a new technique for flourination of solids, including development of a white substance called "perfluorographite."

"Electro-Optical Properties of Molecular Solids" is a report of the work done by Prof. R. C. Jarnagin and associates at the University of North Carolina in studies on radiation damage in molecular crystals. The crystal dosimeter they have developed is described as holding "great promise of solving an old but very important problem in dosimetry."

How to protect the soldier in foreign environments from the ravages of malaria is the subject of "Fundamental Chemistry for the Study of the Topology of Active Sites of Enzimes." This report by Edward

2 at MICOM Increase Gas Laser Oscillator Efficiency

Power and efficiency of gas laser oscillators can be increased without lengthening the laser by using a spectroscopic technique for which two Army Missile Command scientists have filed a patent.

MICOM's formula for this scientific innovation is: Introduce a young Army officer trained in laser research and electrical engineering into a laboratory environment featuring the latest equipment. Cross-fertilize this mixture with the cooperation of civilian scientists in different but related specialties.

Capt George J. Dezenberg, who has a PhD degree in electrical engineering from Georgia Institute of Technology and an MS degree from the University of Arkansas, and Dr. James A. Merritt, his supervisor in the Optical Spectroscopy Branch, Physical Sciences Laboratory, developed the technique.

Results of their experiments are reported in the September 1967 edition of the *Journal of Applied Optics*. Capt Dezenberg presented a paper at the recent symposium of laser engineering of the Institute of Electrical and Electronic Engineers in Washington, D.C.

The patent application has stimulated a number of industrial firms to request information regarding potential applications of the technique.

Most gas laser oscillators have a single optical path through the active medium. A multipath cell permits variation of different optical paths to achieve better coupling of internal laser electromagnetic energy distribution to the "inverted population" medium, that is, the gas.

The MICOM research technique uses a multiple path, controlled by the varied arrangement of mirrors, through the laser cell (as large as four inches in diameter and 21 feet long). This increases power and efficiency through improved coupling (utilization) of the energy available in a flowing mixture of carbon dioxide, nitrogen and helium, by varying the number of passes of the beam through the medium.

Capt Dezenberg believes his two years in the MICOM laboratory have enhanced his professional development — in fact, so appreciably that he plans to continue his work in the laboratory as a civilian when he finishes his tour of military duty. Dr. Merritt is hopeful he will become the third officer with a PhD to remain with the Optical Spectroscopy Branch as a civilian.

SPECTROSCOPIC TECHNIQUE adapted to improve the power and efficiency of gas lasers is demonstrated by Capt George J. Dezenberg of the U.S. Army Missile Command's R&D Directorate, Redstone Arsenal, Ala.

M. Kosower of the State University of New York explains findings relative to various compounds in malarial control.

"Heat-Stable Polymers" is a discussion of the work of J. K. Stille and associates at the University of Iowa in synthesizing several polymers of ladder structure which have unusual stability in high temperatures. "Polyquinoxaline" was found to be stable up to 1,250° F. in the absence of oxygen.

H. I. Schiff of York University reports on "Kinetics of Atmospheric Constituents," including the discovery that reaction of oxygen atoms with hydrogen atoms in the upper atmosphere is chemiluminescent. By monitoring the intensity of light emitted at an appropriate frequency, findings may have important implications concerning the radar blackout problem.

In the Engineering Sciences Division, four reports are presented on notable accomplishments in basic research. "Investigation of the Generalized Leidenfrost Phenomena: Film Boiling of a Discontinuous Liquid Phase on a Flat Plate" is a report on results expected to provide the basis for improved performance of certain rocket nozzles, through a new type of cooling mechanism.

Results of "The Study of Operational Problems and Techniques in Wind Tunnel Testing of VTOL and STOL Vehicles," as reported by W. H. Rae Jr. of the University of Washington, are termed "of immediate interest and value to the effort in understanding, designing and producing V/STOL vehicles of improved performance." Findings are said to have started "showing a payoff to the country's aeronautical effort."

"Research on Damping Mechanisms in Ferrimagnets" by S. Wang of the University of California at Berkeley describes studies of solid-state material known as YIG (an acronym for yttrium iron garnet). Significant commercial and military potential is envisioned for the scanning and modulation of coherent light signals.

Preliminary results of "Analytical Studies in Burning of Initially Unmixed Reactants" are reported by Francis Fendell of TRW Systems. TRW, Inc. The results have interested Army in-house laboratories concerned with development of aerosal sprays to defoliate large areas of forests.

The ARO-D Mathematics Division is represented by two reports. One describes the work of Princeton University's noted Prof. John W. Tukey and his colleagues on "Design and Analysis of Experiments." The new algorithm they have developed, when coupled with improvements in computers, "offers an outstanding improvement over present techniques in the realm of Fourier analysis."

The Lancaster Prize of the Operations Research Society of America, presented a few months ago to Dr. Michel L. Balinski of City University of New York, recognized his work on an ARO-D project, "Discrete Non-Linear Optimization Problems." He has "devised a simple computational procedure which by its simplicity shows advantages in certain cases over existing procedures."

Five of the significant scientific accomplishments supported by ARO-D grants, as listed in the report, are in the metallurgy and ceramics field. Stanford University's A. S. Tetelman is working on "A Study of Strain Hardening and Fracture in Iron-Based Alloys." Indications are that experimental heat treatment may improve properties of structural components processed for military applications.

Results of experiments conducted by E. Scala of Cornell University under an ARO-D grant have pointed to improvement of the mechanical properties of tungsten as a refractory metal through the addition of three percent of rhenium to the alloy. His task is titled "Bonding Interactions of Impurities in Body-Centered-Cubic Transition of Metals and Their Effects on the Ductile-to-Brittle Transition."

Experimentally, O. J. Kleppa of the University of Chicago has determined the heats of formation of kyanite, sillimanite, andalusite and mullite compounds from the oxides. An ARO-D grant has enabled him to calculate the pressure-temperature diagram for the Al_2O_3-SiO_2 system for a wide range of temperatures and pressures. His task is "High-Temperature Calorimetry of Solid Ionic Systems."

"An Investigation of Moisture-Induced Slow Crack Extension in High-Strength Steels," being conducted by H. T. Corten of the University of Illinois, is reported to have established which of two mechanisms - low nominal stresses, and moist environments - is dominant in specific liquid water environments.

Important implications for the designer who, in the choice of materials, must consider corrosion and ablation, are seen in the work of D. E. Rosner of AeroChem Research Laboratories. ARO-D is supporting his "Kinetic Studies of the Attack of Metal Surfaces by Halogen Atoms," an investigation of the effects of gases at surface temperatures above 1,125° C. under controlled conditions.

In addition to the reports on laser research cited at the beginning of this article, the ARO-D Physics Division is funding four studies that have yielded outstanding results. Drs. M. H. Cohen and D. H. Douglass Jr. of the University of Chicago are investigating "Increase of Superconducting Transition Temperature."

They have experimented with pairing of electrons in metals separated by an insulating barrier in the form of a "sandwich," with results described as "very interesting."

"Emission of Radiation from a System of Many Excited Atoms" reports on a study by Drs. P. Stehle and V. Ernst of the University of Pittsburgh.

The main results obtained from their model "are that the system emits radiation only in the form of one single narrow bundle of photons, the wave vectors of which are distributed around a certain center. . . In particular, this provides a simple explanation of the existence of laser activity without mirrors which has been found by Lempicki and Heller, and Bennett et al."

Dr. L. Esaki of International Business Machines Corp. is engaged in an ARO-D supported study titled "Superconducting Semiconductors," which is concerned with the possibility of tailor-making a superconductor out of semiconducting materials. Results "go a long way toward explaining the superconducting behavior of these semiconductors which may have important application in switching devices."

"Considerable scientific attention" has been aroused, states the ARO-D report on "Scientific Accomplishments in Basic Research," by results of the work of Dr. H. A. Fairbank of Duke University on "Second Sound." This study is concerned with a question scientists have discussed at great length since 1951.

Dr. Fairbank's experiments resulted in the detection of the second-sound effect in solid helium - the first discovery of this phenomenon, although the question of whether the second sound will propagate in solids has long received theoretical attention.

TECOM Designates Tully Head of Infantry Materiel Testing

Lt Col Robert B. Tully is the new chief of the Infantry Materiel Testing Directorate, U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, Md. He recently completed a tour in Vietnam with the 1st Cavalry Division (Airmobile).

Col Austin Triplett Jr., who headed the directorate, is now assigned to the U.S. Military Assistance Advisory Group in Norway.

Col Tully is a 1946 graduate of the U.S. Military Academy and served with the 187th Regimental Combat Team in Korea in 1950-51. Graduated from the Command and General Staff College in 1959, he completed the Army War College course in 1967.

Among his decorations are the Silver Star, Bronze Star Medal with "V", Air Medal with Oak Leaf Cluster, Joint Staff Commendation, Vietnam Gallantry Cross, and Combat Infantryman Badge with Star.

Lt Col R. B. Tully

Col W. H. Vinson Jr.

Col J. J. Doody

Lt Col B. W. Allen Jr.

Lt Col J. F. Culp

OCRD Announces 21 Staff Assignments

Nineteen highly educated officers and two civilians have been assigned recently to headquarters elements of the Office of the Chief of Research and Development (OCRD), Department of the Army.

COL WILBUR H. VINSON JR. returned to OCRD as chief of the Nike-X and Space Division, having served from 1963 to 1965 as chief of the division's Nike-X Branch.

In Vietnam until July, Col Vinson served six months as deputy commander, 1st Cavalry Division, Artillery, and six months as commanding officer, 2d Battalion, 19th Artillery, 1st Cavalry Div.

A 1945 graduate of the United States Military Academy (USMA), he received an MS degree in mechanical engineering from the University of Southern California in 1962. He has attended the Command and General Staff College (C&GSC), Fort Leavenworth, Ky., and National War College, Washington, D.C.

COL JOHN J. DOODY is the new chief of the Test and Evaluation Branch, Management and Evaluation Division.

A staff officer in the OCRD Combat Materiel Division (1965-66), he has served as battalion commander, 4th Infantry Division, Fort Lewis, Washington, and as secretary of the General Staff, Eighth U.S. Army, Korea.

Graduated from the USMA in 1948, he received an MS degree in business administration from George Washington University in 1967. Col Doody is also a graduate of the C&GSC and the Industrial College of the Armed Forces.

LT COL BOYDE W. ALLEN JR. returns to the Space Branch, Nike-X and Space Division, as the new chief, having served in that branch as action officer (1963-66).

He also served as unconventional warfare officer, Special Warfare Branch, J-3 Division, HQ United Nations Command/U.S. Forces Korea (1966-67).

Graduated from the USMA with a BS degree in 1949, Col Allen received an MS degree in mechanical engineering from the University of Southern California in 1957.

He is credited with the development of the satellite communications terminals AN/MSC-46 and AN/TSC-54.

LT COL JAMES F. CULP moved to OCRD after service in Vietnam. Assigned to the Military Advisors Branch, Studies and Analyses Division, he served in Southeast Asia as battalion commander, 2d Battalion, 9th Artillery, 1st Cavalry Division.

Previous assignments include: chief, Readiness Branch, assistant chief of staff G-3, XVIII Airborne Corps, Fort Bragg, N.C.; training officer, S-3, VII Corps Artillery, Germany; and commander of Battery B, 2d Howitzer Battalion, 34th Artillery, Germany.

Col Culp received a BA degree in mathematics from Texas A&M University and is a graduate of the U.S. Army Artillery and Missile School and the Command and General Staff College.

LT COL SAMUEL J. HUBBARD has been assigned to the Scientific and Technical Information Division, Army Research Office, following duty in Vietnam as a company commander and executive officer of the 227th Assault Helicopter Battalion, 1st Cavalry Division.

He was with HQ U.S. Army Europe (USAREUR) 1963-66 in the Aviation Detachment and Operations Division, following a year with Battle Group and Brigade S-4, 24th Inantry Division, USAREUR.

A 1952 graduate of the USMA, he has attended the C&GSC and various Infantry and airborne schools.

LT COL WALLACE H. HUBBARD, another OCRD "alumnus," has been assigned to the Combat Arms Branch, Combat Materiel Division. He was with the Missiles and Space Division from 1961 to 1964.

His intervening assignment was executive officer, U.S. Army Section, Joint U.S. Military Aid Group, Greece.

Graduated from the USMA in 1948, Col Hubbard earned an MS degree in mechanical engineering from the University of Southern California. He has also attended the C&GSC and the Armed Forces Staff College.

LT COL JAMES H. W. INSKEEP has been assigned as chief, Policy Branch, Management and Evaluation Division.

His previous service has included: executive officer, Military Assistance Directorate, HQ United States European Command; battalion commander, 2d Target

Lt Col S. J. Hubbard

Lt Col W. H. Hubbard

Lt Col J. H. W. Inskeep

Lt Col W. A. Klein

Lt Col S. J. Kuick

Lt Col C. F. Lemr

Lt Col D. A. Nixon

Lt Col J. H. Reeve

Acquisition Battalion, 26th Artillery, Fort Bragg, N.C.; HQ Defense Atomic Support Agency (DASA), Washington, D.C.; and executive officer, 1st Observation Battalion, 25th Artillery, Korea.

Col Inskeep graduated from the USMA in 1946 and has attended the Officers Guided Missile School, the C&GSC and the Armed Forces Staff College.

LT COL WALTER A. KLEIN's new position as staff officer, Programs Branch, Programs and Budget Division, follows service in Vietnam as J-3, Research and Development Requirements Branch.

Col Klein's previous service with the Corps of Engineers includes: R&D Directorate, HQ Army Materiel Command, Washington, D.C., and assistant post engineer, Seventh Army Training Center, Grafenwohr, Germany.

Graduated from the USMA in 1951, he has earned an MBA degree from Hofstra College (1958) and a master of engineering from Texas A&M University (1960).

LT COL STANLEY J. KUICK, staff officer in the Studies Branch, Studies and Analyses Division, formerly commanded the 1st Battalion, 28th Infantry, 1st Infantry Division Vietnam.

He also served with that division in Vietnam as executive officer and as deputy G-3. Other service has included instructor, Weapons Orientation Advanced Course, Training Group, Sandia Base, N. Mex., and company commander, 17th Infantry, 7th Infantry Division, Korea.

Col Kuick graduated in 1952 from the USMA and received an MS degree in physics from Tulane University in 1962. He has attended the C&GSC.

LT COL CHARLES F. LEMR was assigned to the OCRD Plans Division from the U.S. Army Europe, where he was action officer, Special Weapons, Office of the Deputy Chief of Staff for Operations, since May 1966. From 1964 to 1966, he was nuclear weapons effects officer, Chemical Division, USAREUR.

While assigned from 1960 to 1964 as instructor in the Radiological Branch of the Chemical Center and School, Fort McClellan, Ala., he earned an MS degree in chemistry from Western Reserve University (1962). He also holds a BS degree from that university.

LT COL DONALD A. NIXON, new staff officer in the Combt Support Aircraft Branch, Air Mobility Division, returned recently from Vietnam, where he served on the staff of the 1st Cavalry Division and as commander of an armed helicopter company.

He has served as Infantry company commander, 505th Airborne Infantry Regiment, Fort Bragg, N.C., and as assistant S-3, 22d Infantry Regiment, European Command.

Graduated with a BS degree from the USMA (1952), Col Nixon earned an MS degree from the University of Arizona in 1966. He is a C&GSC graduate.

LT COL JOHN H. REEVE, former chief of the Army Operations Center, HQ U.S. Army Vietnam, has been assigned to the Requirements and Resources Division of the Nike-X System Office.

He went to Vietnam in 1966 after receiving a master's degree in mechanical engineering from the University of Arizona and attending the C&GSC (1963-64). From 1960 to 1963, he served with the Southern European Task Force as a firing battery commander and as operations officer for the assistant chief of staff G-3. He holds a BS degree in agronomy from Utah State University (1952).

LT COL JOHN T. QUINN is assigned to the Management and Evaluation Division. From September 1966 to June 1967, he was executive officer of the 2d Battalion, 28th Infantry, 1st Infantry Division and G-2 Plans, HQ II Field Force Vietnam. He was an adviser to the Army of the Republic of Vietnam Ranger Battalion in 1962-63.

Between assignments in Southeast Asia, Col Quinn was on the staff and faculty of the U.S Army Infantry School at Fort Benning, Ga.

A 1952 graduate of the USMA, he has attended the C&GSC.

LT COL HAROLD A. TERRELL JR. was assigned to the Nike-X System Office shortly after receiving a master's degree in business administration from George Washington University. He has an MS degree in electronic engineering from Georgia Institute of Technology (1955), and a BS degree in military engineering from the USMA (1946) where he was a mathematics instructor from 1958 to 1961.

Col Terrell also attended the Industrial College of the Armed Forces in 1967, following completion of a tour in Germany as commander of the 5th Battalion, 77th Artillery, the unit of which

(Continued on page 16)

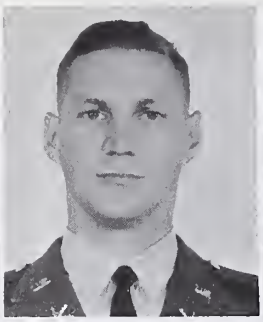
Lt Col J. T. Quinn

Lt Col H. A. Terrell Jr.

Lt Col E. C. West

Lt Col S. L. Wilhelmi

Maj G. S. Kourakos



Maj F. J. Palermo Jr.

Maj J. G. Ton

Dr. A. J. Emery Jr.

Dr. J. I. Bryant

OCRD Announces 21 Staff Assignments

(Continued from page 15)

he was executive officer in 1962-63. He was operations staff officer, G-3 section, HQ Seventh Army, Germany, 1963-64.

Col Terrell attended the C&GSC in 1962.

LT COL EDWARD C. WEST, who this year received an MS degree from George Washington University and also attended the Industrial College of the Armed Forces, has been assigned to the General Materiel Branch of the Combat Materiel Division.

He has an MS degree from Massachusetts Institute of Technology (1956), a BS degree from the USMA (1950), and has completed courses at the C&GSC and the Armed Forces Staff College.

Col West was commanding officer of the 44th Engineer Battalion 1965-66, following three years with the Infantry Combat Developments Agency as engineer adviser and branch chief. He was company commander and S-3 of the 588th Engineer Battalion 1960-61, after three years in France as area engineer and design coordinator of the Joint Construction Agnecy.

LT COL SYLVESTER L. WILHELMI, staff officer in the Research Plans Office, recently completed a tour in Vietnam as a J-3 (War Plans) action officer, HQ Military advisory Command. He served from 1963 to 1966 with the Combat Developments Command Engineering Agency, Fort Belvoir, Va.

Col Wilhelmi received a BS degree from Iowa State University in 1951 and an MA degree in education from the University of Illinois. He has attended the C&GSC.

MAJ GEORGE S. KOURAKOS has been assigned to the Studies and Analyses Division, Army Research Office, with 90 days temporary duty with the Plans Division, OCRD. He was an action officer (1962-65) in the OCRD Communications Electronics Division.

In 1966-67 he served in Vietnam as brigade S-2, deputy G-2 and G-2 with the 1st Infantry Division, after attending the C&GSC. A 1954 graduate of the USMA, he has an MS degree in electrical engineering from the Georgia Institute of Technology.

MAJ FRANK J. PALERMO JR. is assigned to the Space Branch, Nike-X Space Division, after service in Vietnam, where he was a task force adviser, Vietnamese Airborne Division, and manpower control officer, HQ Military Command.

Previous service includes assignments as assistant G-3, 82nd Airborne Division, and mortar battery commander, 2/504 Infantry, Fort Bragg, N.C.

Maj Palermo received a BA degree in classical languages from Xavier University in 1952 and an MS degree in aerospace engineering from the University of Arizona. He has gruaduated from the C&GSC and the Armed Forces Staff College.

MAJ JAMES G. TON is a new staff officer in the Physics, Electronics and Mechanics Branch of the Physical and Engineering Sciences Division.

Previously an area engineer, U.S. Army Engineer Division Mediterranean, Turkey, he has also served as atomic demolitions munitions officer, G-3, U.S. Army Pacific, Fort Shafter, Hawaii; operations officer, 65th Engineer Battalion, 25th Infantry Division, Schofield Barracks, Hawaii; and commander of Company E, of the same battalion.

After earning a BEE degree from the City University of New York, Maj Ton received an MS degree in civil engineering from Massachusetts Institute of Technology. He is a graduate of the C&GSC.

DR. ARTHUR J. EMERY JR. is a newcomer to the Scientific Analysis Branch of the Life Sciences Division. With the University of Maryland School of Medicine, he has been an assistant and associate professor since 1957.

He received a PhD degree in biochemistry in 1954 from the University of Rochester School of Medicine and Dentistry, and remained there as a biochemist in the Flash Burn Section of the Atomic Energy Project and as an instructor until 1957. He holds a BS degree in biology from Bucknell University.

Dr. Emery was chairman of the Maryland Section of the American Chemical Society in 1964.

DR. JAMES I. BRYANT is a newcomer in the Physical and Engineering Sciences Division, Army Research Office. Since 1959, he has been a physical chemist at the U.S. Army Mobility Equipment R&D Center (until recently the Engineer R&D Laboratories), Fort Belvoir, Va.

From 1956 to 1958, he was a medical laboratory technician and then a research assistant at the Veterans Hospital in Louisville, Ky.

Dr. Bryant has a BS degree from Kentucky State College (1951), and did graduate work at Michigan State University (1953-54). He received an MS degree in 1958 and a PhD degree in 1961 from Howard University, where he was a graduate teaching Fellow.

A specialist in molecular spectroscopy and infrared and Raman spectroscopy of crystalline solids, he received an Achievement Award from the Scientific Research Society of America in 1963.

ECOM Survey Reflects Growing Use of IC

Rapid growth in the use of integrated circuitry by the U.S. Army Electronics Command was shown in a recent survey of new equipment under development, reflecting an overall 28 percent of projects reviewed.

The Electronic Components Laboratory study revealed that ICs are incorporated in 36 percent of the projects surveyed in the Communications and Automatic Data Processing Laboratory. In the Combat Surveillance, Night Vision, and Target Acquisition Laboratories, the average was 28 percent; in the Avionics Laboratory, 16 percent.

Integrated circuitry has been specified or is being considered in another 41 percent of possible applications by these laboratories. The study is being extended into other ECOM laboratories, notably the Electronic Warfare and Atmospheric Sciences.

Dr. Eduard A. Gerber, director of the Electronic Components Laboratory, said that ICs will be used in all areas of application where they will offer significant advantages in performance, size, weight or logistics as compared to other circuits.

CIDS Exploratory Project Nearing Test Phase

The time is rapidly approaching when the research chemist's dream of having quick access to data describing the characteristics of millions of chemical compounds may become a reality. A system for this purpose is being explored by the Army's Chemical Information and Data System (CIDS) project.

The system is under development at Edgewood Arsenal, Md., under the staff supervision of the Director of Army Research, Office of the Chief of Research and Development.

Primary responsibility for the CIDS project is assigned to the U.S. Army Materiel Command, which has delegated execution responsibility to the U.S. Army Munitions Command. The Office of The Surgeon General is responsible for certain aspects of the developmental effort.

The compound structure, substructure, nomenclature and bibliographic references for several million chemical compounds of interest to the Army may eventually be incorporated into the system. This data and information can be made readily available to the research chemist through a computer-linked communication network.

CIDS has been established as an exploratory development project for the following primary purposes:

- To determine the feasibility of handling chemical and related information by automated techniques.
- To evaluate resource requirements and procedures for the establishment of a prototype system.
- To determine the specific Army needs and the basis for projection of an operational system.

The basic guideline is that the system support on-going work in a prompt and efficient manner.

Two Army installations are contributing to the CIDS effort — Edgewood Arsenal and the Walter Reed Army Institute of Research. Frankford Arsenal has the responsibility for IDEEA project which has an important interface with CIDS, since it is to establish the prototype network configuration for chemical as well as other specific data.

The major effort for CIDS in AMC is being conducted by the University of Pennsylvania, under a contract with Edgewood Arsenal. The initial results of this contract are an Action Plan and the Design for an Initial Experimental System for storing and retrieving chemical data and information required by the Army in the pursuit of its research and development activities.

The Action Plan identified those areas of research and development which required in-depth probing in order to develop a prototype CIDS system. The plan encompassed 39 specific tasks which were appropriately time-phased for orderly development of the system. Although the tasks could be categorized in various ways, they were designed fundamentally to guarantee adequacy with respect to:

- All pertinent aspects of basic chemistry and chemical technology;
- The current and near future states-of-the-art of automated storage, retrieval and transmission of information;
- All bands of the broad spectrum of data needs of the Army for chemical data and information; and

Economic and other characteristics of practical moment, such as response time, facilities, personnel, etc.

Based on this initial output, an AMC Master Plan for the CIDS project has been prepared. The overall objective of this Master Plan is to demonstrate user needs and acceptance. This result is to be based on pilot tests with respect to logic, systems and programs, and data and information designed to establish the specific needs which exist for a future Army-wide automated system for chemical data and information.

In order to meet this objective, current effort is being devoted to the development of programs and procedures for the organization, manipulation, search and maintenance of data banks containing both structural and nonstructural data and information. In the development of the programs referred to above, there are three main components of the CIDS system that must be taken into consideration; namely, files, equipment and programs.

Currently, three source files are available for the demonstration of user needs and acceptance. One is a file of approximately 600,000 compounds with limited data obtained from the Chemical Abstracts Service under contract with the National Science Foundation.

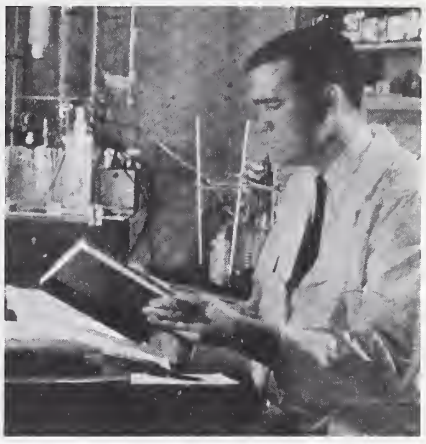
In addition, there are about 65,000 compounds from the Chemical Biological Coordination Committee file and approximately 12,000 from the Toxicological Information Center file at Edgewood Arsenal. The latter two sources have data in depth associated with the compounds.

Edgewood Arsenal and its contractor are now operating six Mergenthaler chemical typewriters and four Duramach chemical typewriters in its mechanized file-building program.

Approximately 16 computer programs and routines have been developed to assign keys, convert tapes from one format to another, and to verify, search, and otherwise manipulate the files.

The rate of compound data entry into the system is currently about 4,000 compounds per week. It is estimated that the files will contain data covering 500,000 compounds for testing purposes by January 1968. An operational system may ultimately contain data on as many as 3,500,000 compounds.

The prototype system will contain the following "hard-core" data elements for each chemical compound: registry number, structural formula, molecular formula, security status, nomenclature, bibliographic references, kinds of data and data locations.



OPERATIONAL CIDS may enhance effectiveness of the research chemist.

Hundreds of other items of information also may be associated with any one compound.

The compound encoding process involves the use of a storage procedure based upon descriptors, or "keys." A key is an identifier of a specific structural or nonstructural characteristic of the data associated with each compound.

For example, structure is characterized by a key for each of the substructural characteristics; taken together the structural keys represent the structure of a compound. The nonstructural keys similarly characterize specific chemical, physical, biological and other properties of the compound. These keys provide a vocabulary or index according to which any compound can be stored in the data bank and selectively retrieved. It is estimated that a vocabulary of 15,000 to 29,000 key

(Continued on page 18)

ENCODING the chemical compound structure on Army Chemical Typewriter.

United Kingdom Joins Three Nations in Mallard Project

Four nations are now linked in the Mallard Project, an 8-year estimated $126 million R&D program to produce a tactical communications system for field armies and associated navies and air forces. The United Kingdom joined with the United States, Australia and Canada in mid-September.

Brigadier Ronald G. Miller has been designated as UK project and program manager for Mallard. Formerly he was in Paris with NATO as Deputy Standing Group Representative, Communication Electronics and chairman, Allied Military Communication Electronics Committee. Earlier he was the first Chief Signal Officer of the then newly formed Commonwealth Army Communication Network.

Brig Gen Paul A. Feyereisen, U.S. Army, is the U.S. program/project manager and Lt Col L. G. Moore, OBE, and Lt Col D. C. Coughtry, CD, are respectively the managers for Australia and Canada.

The Mallard Project will provide, secure, fully automatic switched communications in the battlefield areas from field army headquarters down to battalion level. It will include facilities for the transmission and reception of voice, telegraph, data and facsimile messages.

The system will use building-block or modular principle of equipment construction to ensure flexible inter-operation between the four field armies.

Initial work on the project was carried on during one year of meetings between representatives of the four countries, whose report defined operational and technical requirements and proposed an R&D plan.

In April 1967, the United States, Australia and Canada ratified an agreement to proceed with the Mallard Project. The United Kingdom deferred participation pending decision on sharing the costs and work.

In the initial development phase of the Mallard Program, competitive system design studies will be carried out by U.S. and U.K. electronics industries.

Supporting technique efforts are being conducted mainly by United States, Australian and Canadian industrial concerns although UK industry will participate.

Brigadier Ronald G. Miller

CIDS Exploratory Project Nearing Test Phase

(Continued from page 17)

terms may be required for an operational CIDS.

To meet CIDS requirements for a practical and efficient information retrieval system, the processing unit must have the capability;

- To accept a query asked by a chemist, including structural representation if desired;
- To perform an optimally efficient search of the data bank; and
- To provide the information in a prescribed format.

The format may be in terms of a chemical typewriter output, which functions as a low-speed printer and will probably satisfy the needs of most research chemists. However, for other users of CIDS, including project managers as well as chemists, a high-speed chemical data printer will be available.

A User Advisory Group was appointed by AMC in March 1967 to evaluate the utility of CIDS to the Army. This group represents the major subcommands of AMC and the laboratories reporting directly to AMC. An analysis of 240 chemical queries submitted to CIDS from 14 Army installations in connection with the user evaluation program has shown that 24 percent are structural in nature; 38 percent are part structural and part nonstructural; and 38 percent are exclusively nonstructural. CIDS is presently responsive to structural questions, but requires augmented data for nonstructural queries.

Six other government agencies have recently expressed a desire to cooperate in the CIDS program. An experimental effort to determine the usefulness of the CIDS system to these agencies has been proposed. The Army has agreed to cooperate with these agencies to the extent that the proposed experimental programs are mutually beneficial.

An operational CIDS is visualized as consisting of a network in which a Central Referral Center is linked with Technical Information Centers and Laboratories. The Central Referral Center would maintain all of the compound structural data as well as records of the kinds of data and nonstructural information which are known to the system for each compound in the system, together with the locations of the data.

When specific data or information other than structural is required by the chemist, it would be provided by referral to the automated and manual files maintained at Technical Information Centers.

It is anticipated that an operational CIDS may greatly enhance the effectiveness of the research chemist in his efforts to select or to synthesize compounds to meet the complex chemical and materiel requirements of the modern-day Army.

TRIPARTITE CAKE CUTTING was a feature of the dedication of new facilities for the Mallard Project at New Shrewsbury, N.J., just prior to addition of the United Kingdom to link 4 nations in a quadripartite communications system effort. Shown (l. to r.) are Lt Gen Jonathan O. Seaman, CG, First U.S. Army; Lt Col Lisle G. Moore, Mallard program manager for Australia; Lt Col Douglas C. Coughtry, Canadian program manager; Brig Gen Paul A. Feyereisen, U.S. program manager; and Rep. James J. Howard of the New Jersey Third Congressional District. The Mallard Building supplants overcrowded office and laboratory space formerly used by project personnel in the Hexagon (2.5 miles away), HQ U.S. Army Electronics Command. For activities of the 8-year multimillion dollar Mallard communications program, see May 1967 issue of the *Army R&D Newsmagazine*.

O'Donnell Heads MECOM R&D Center

Command of the U.S. Army Mobility Equipment Command's Research and Development Center, Fort Belvoir, Va., was assumed recently by Col Edwin T. O'Donnell.

Col Frank Milner, his predecessor, retired Aug. 22 and was presented an Oak Leaf Cluster to the Legion of Merit for exceptional service at the former Army Engineers R&D Laboratories.

Col O'Donnell's last assignment was in Hanau, Germany as commander of the 37th Combat Engineer Group and before that he was assigned to the Plans and Policy Division at HQ SHAPE in Paris.

He attended the University of Michigan for two years, was graduated from the U.S. Military Academy in 1944, has a master's degree in civil engineering from the University of Illinois (1952), and has graduated from Command and General Staff College, and National War College.

Col Edwin T. O'Donnell

Engineer Topographic Labs Get New Commander

Col Edward G. Anderson Jr. is the new commander of the U.S. Army Engineer Topographic Laboratories (USAETL), until recently the U.S. Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency (GIMRADA), Fort Belvoir, Va.

The change of comand took place in mid-September following retirement of Col Hamilton W. Fish after 30 years of service.

Col Fish was awarded the Legion of Merit by Chief of Engineers Lt Gen William F. Cassidy for service as GIMRADA commander since January 1966. Col Anderson received the First Oak Leaf Cluster to the Legion of Merit for his preceding tour as CO, 36th Engineer Group (Combat) and Corps Engineer, I Corps (Group), Korea, from July 1966 to July 1967.

Col Anderson received his first Legion of Merit in 1966 for services as chief of the Missile and Space Branch and as chief of the Topographic Sciences Division, Directorate of Topography and Military Engineering, in the Office of the Chief of Engineers.

He holds a BS degree in commercial engineering from the University of Washington (1962), and master's degrees in civil engineering from Texas A&M (1950) and industrial engineering from Stanford University (1955). He has completed the Engineer Officer's Advanced Course at Fort Belvoir (1953), the U.S. Army Management School (1964), and the Army War College (1966).

Since his initial assignment in 1942, with the 69th Coast Artillery in San Diego, Calif,. Col Anderson has served various tours throughout the U.S., Europe and the Far East.

CHIEF OF ENGINEERS Lt Gen William F. Cassidy pins Legion of Merit (First Oak Leaf Cluster) on Col Edward G. Anderson Jr., now commanding the U.S. Army Engineer Topographic Labs.

MECOM R&D Center Tests Floating Hoseline System

An 8-inch floating hoseline system designed for rapid transfer of fuels from Army lighters and barges to collapsible containers on shore — at the rate of 1,500 barrels an hour — is being tested at the U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, Va.

Designed and fabricated "in-house," the system is expected to provide major advantages over the present method of floating 55-gallon barrels to the beach during assault operations.

In operation, the reel-mounted hoseline is positioned on the beach and payed out to the anchored bulk carrier as far as 1,000 feet offshore. Upon completion of the off-loading, it is retrieved for reuse.

The lightweight hose is fabricated in 50-foot lengths to permit rapid replacement of damaged sections. Designed to withstand barge or lighter pump pressure with minimum twist and stretch, it has a 6-month service life.

Army Terminates Project On High Altitude Research

Project HARP-McGill, a joint U.S. Army-Canadian Department of Defense high-altitude research probe program with 16-inch guns, was terminated with the recent expiration of contract with McGill University, Montreal.

Negotiations for an "orderly close out" of Project HARP-McGill are under way. The 16-inch surplus gun barrels, modified during the program for high altitude atmospheric research, are located at Barbados, West Indies; Yuma (Ariz.) Proving Ground; and Highwater, Canada.

Project HARP-McGill was based on the use of gun-launched projectiles and rockets to make scientific soundings and studies of the upper atmosphere.

Army and McGill experts believe that the project achieved a considerable degree of progress. It proved out the feasibility of the use of gun probes for atmospheric research. It collected "considerable data on conditions of high atmosphere" which made it possible to study and correlate information on ionized layers and winds.

Additionally, the project provided exploratory development on vehicle probe design and instrumentation as well as on gun technology.

A U.S. Army-McGill University contract of $2,000 was the beginning of the project in 1962. The U.S. Army Transportation Corps delivered two 140-ton barrels and a complete mount at Barbados beach, a landing of the heaviest items across-the-beach in Army history. In 1963, projectiles were fired to an altitude of 340,000 feet.

Engineers of McGill's Space Research Institute attached a second barrel and modified the elevation system of the Barbados 16-inch gun in 1965. The change increased the firing altitude to 86 miles (455,000 feet). The vertical-fire 16-inch gun at Yuma Proving Ground set a record altitude of about 111 miles (590,000 feet), using an improved ignition system.

The Highwater gun was used for horizontal test firings for development of gun propellants, projectiles, and rocket motors prior to vertical firings at Barbados and Yuma.

Highwater was a "very high velocity" aerodynamic test facility. Peak muzzle velocity of 8,400 feet per second enhanced engineers' study of hypersonic heat transfers, pressure measurements and the use of guns for launching advanced propulsion units.

Wire, Cable Meet Set Nov. 29-30

A panel discussion on wire communication in Southeast Asia will be held along with presentation of 24 papers at the 16th Wire and Cable Symposium, Nov. 29-30, in Atlantic City. The meeting is sponsored by industry and the U.S. Army Electronics Command's Electronic Components Laboratory, Fort Monmouth, N.J.

Army RDT&E, Procurement Contracts Top $1 Billion

Army contracts exceeding $1 million each for research, development, test, evaluation and procurement totaled $1,035,368,521 from July 27 to Sept. 8, exceeding the $1 billion mark for the second time in a row.

Western Electric Co. received three contracts totaling $231,438,960 for work related to the Nike-X missile system. The largest was $215,270,329 for continued R&D to be performed by Bell Telephone Labs, Western Electric, Martin-Marietta Co., Raytheon Co., Sperry Rand Corp., General Electric Co. and the McDonnell-Douglas Corp.

Western Electric also received a $13, 168,631 modification to a contract for deployment planning activities for the Nike-X, and a $3,000,000 modification for R&D facilities.

Chrysler Corp. received five contracts totaling $80,434,059 — $49,152,044 for M60A1 tanks, trainers, and M728 combat engineer vehicles with repair parts, and $19,000,000 for 175mm projectiles, and the remainder for forklift trucks and cargo trucks.

Bell Aerospace Corp. was awarded $65,459,613 in contracts for UH-1H helicopters ($37,656,217), AH-1G helicopters ($25,170,000), tail rotor hub assemblies and crash damage repair kits.

A modification of $43,801,904 went to the Federal Cartridge Corp. for 5.56 and 7.62mm cartridges. The Sperry Rand Corp. will receive $37,068,642 for large-caliber projectiles. Texas Instrument, Inc., will furnish electronics equipment for $35,000,000.

Ten contracts and modifications totaling $31,519,579 will procure from the Raytheon Co. bomb fuzes, anti-intrusion warning mines, advance development of SAM-D missiles, and guidance and control component sets, ground support equipment, rebuilt stabilized magnetron assemblies and refurbished launchers for the Hawk missile.

Colt's Inc. will supply M16A rifles and rifle barrel assemblies for $27,959, 371. FMC Corp. was awarded two contracts totaling $25,063,000 for armored personnel carriers, cargo carriers and metal parts for high-explosive projectiles.

The Kaiser Jeep Corp. received a modification of $23,134,615 for 1¼-ton vehicles. Mason and Hanger, Silas Mason Co., Inc., was awarded a $22,235,724 modification for ordnance items. R. G. LeTourneau, Inc., will receive $18,595, 500 for metal parts for 750-pound bombs.

Page Aircraft Maintenance, Inc., will receive $17,100,000 for nine months of aircraft maintenance. Remington Arms Co., Inc., was issued a $16,249,267 modification for 7.62 and 5.56mm cartridges.

Five contracts totaling $15,070,379 with the General Motors Corp. will procure mortar projectiles, tank transmission assemblies, diesel engines and squad radio sets. Machlett Laboratories, Inc., received two modifications totaling $14, 145,477 for miniscopes for the night vision program and 25mm image intensifier assemblies.

Memcor, Inc., received a $14,115,389 modification for receiver-transmitter portions of vehicle radio communications sets. The Caterpillar Tractor Co. won modifications totaling $13,048,247 for tractors.

On four contracts totaling $12,563,447, Continental Motors Corp. will furnish truck multifuel engines, tank engines, and rebuilt engines for trucks. The Olin Mathieson Chemical Corp. will receive $12,533,102 for propellants and 81mm illuminating projectiles.

Firestone Tire and Rubber Co. won three contracts totaling $12,205,773 for pneumatic tires for earth-movers and track-shoe assemblies for armored personnel carriers, tanks and combat engineer vehicles. Four contracts totaling $9, 964,094 will produce projectile parts from the Chamberlain Manufacturing Corp.

Honeywell, Inc., will supply metal parts for bomb fuzes and multiplexer components for $9,955,021. The Magnavox Co. received a $9,366,688 modification for radio sets.

Union Carbide Corp. was awarded three contracts totaling $8,449,499 for dry batteries, radio sets and fuze components. Dyna Electron Corp. obtained an $8,312,105 contract order for aircraft maintenance. Two contracts totaling $7, 764,196 with Lear-Siegler, Inc., will

Edgewood Arsenal Selects First Technical Director

Edgewood (Md.) Arsenal's first technical director is Dr. Charles A. Reynolds, a 44-year-old professor of chemistry at the University of Kansas until he left in September for duty at the Army chemical research center.

Selection of Dr. Reynolds ended an extended search for a man with the desired qualifications, and is based on a career in the academic community as well as work with the Operations Research Group at the Arsenal from 1951 to 1953.

During that period of government service, he also was technical adviser to the Chief Chemical Officer and a consultant for the Weapons Systems Evaluation Group, Office of the Joint Chiefs of Staff.

Dr. Reynolds has been associated with the University of Kansas since 1947 except for the 2-year absence for duty with the Chemical Corps. He has been a professor since 1961 and has served as associate chairman of the Department of Chemistry.

Dr. C. A. Reynolds

In his new position, he is responsible for the technical aspects of the research, development, engineering, quality assurance, manufacturing, mobilization planning and procurement program of Edgewood Arsenal.

Dr. Reynolds aids the commander in reviewing military requirements to determine actions necessary to meet tactical and logistics requirements as well as satisfy research needs.

Dr. Reynolds received his AB, MA and PhD degrees in chemistry from Stanford University, Calif. He is the author of a college textbook, "Principles of Analytical Chemistry," and coauthor of more than 20 scientific publications which have been published in various national journals.

FIRST PRODUCTION MODEL of 1,-600,000 M17A1 protective masks, produced under a $28.9-million contract, is presented to Brig Gen William W. Stone, former CG, Edgewood Arsenal, where the new defensive mask was developed. Charles K. Keck Jr., the arsenal's commodity manager for the mask, makes the presentation in behalf of the manufacturer, the Mine Safety Appliances Co. Adopted for Army-wide use, the mask is considered a breakthrough in the critical area of chemical defense equipment in that the wearer can drink water or administer resuscitation without risk of contamination.

procure fuze parts and tank generator assemblies.

General Dynamics Corp. will receive $7,747,719 for items for the manufacture of FY 68 Redeye weapons system hardware. U.S. Steel Corp. will provide howitzer projectile parts for $6,308,100 and will receive $1,000,000 for reactivation, repair and relocation of government equipment in the Berwick, Pa., facility.

Martin-Marietta Corp. received two contracts totaling $7,294,883 for improved Pershing ground-support equipment and metal parts for aerial mines. A. O. Smith Corp. will receive $6,843,406 for bombs and Hanson Machinery Co. was awarded a $6,177,911 modification for 5-ton cranes.

AVCO Corp. won three contracts totaling $5,993,715 for projectile components, turbine engine nozzles and blade sets. Radio Corp. of America will provide radio sets and receiver/transmitters on a $5,992,686 modification and Allis-Chalmers Manufacturing Co. received a $5,975,555 modification for scoop loaders.

Norris Industries, Inc., was issued a $5,694,770 modification for cartridge cases. Bell and Howell Co. gained a $5,614,565 contract for metal parts for time fuzes and the Anthony Co., $5,577,988, for rough-terrain forklift trucks.

Hughes Aircraft Co. was awarded $4,900,000 contract for industrial services on the TOW missile. Sylvania Electronic Systems will provide anti-intrusion warning mines for $4,862,563 and Bucyrus Erie Co. will get $4,773,600 for cranes.

LSI Service Corp. will provide aircraft maintenance in Vietnam for $4,724,379 and two contracts with Amron Corp. will furnish projectiles and cartridge cases for $4,414,518. Emerson Electric Co. received a $4,382,620 modification for XM28 aircraft armament subsystem repair parts.

Rulon Co. will receive $4,376,058 for metal parts for fuzes. General Electric Co. was awarded three contracts totaling $4,274,034, including $340,000 to a $6,400,000 contract for design, fabrication and test of an advanced technology 1,500-hp. gas turbine demonstrator engine. Improvement kits for the Hercules missile system and radar sets will also be purchased.

Eureka Williams Co. received a $4,044,944 modification for metal parts for bomb nose fuzes. ITT Corp. received contracts totaling $3,810,017 for communication systems repair parts and installation, materials and services for interconnection, testing and alignment of communication equipment.

United Aircraft Corp. received $340,000 on a $3,750,000 contract for the design, fabrication and testing of an advanced technology 1,500-hp. aircraft gas turbine demonstrator engine. Koehring Co. received a $3,673,357 modification for ditching machines. John Wood Co. won a $3,672,240 contract for fin assemblies for bombs.

American Optical Co. will receive $3,621,651 for periscopes and spare parts. Northrop Corp. will furnish Hawk launchers for $3,376,540. Unidynamics-Phoenix Division, was awarded a $3,274,944 contract for illuminating projectiles. Strick Corp. received a $3,074,103 modification for 12-ton semitrailers.

L. T. Industries, Inc., will provide fin assemblies for bombs for $2,860,650. Frequency Engineering Labs received a $2,841,900 modification for compact, light relay sets for ground troops. International Harvester Co. was awarded a $2,693,023 contract for tractors.

Independent Lock Co. will furnish fuze parts for $2,637,765. Farmers Chemical Association, Inc., will supply support services for manufacture of TNT on a $2,415,186 modification.

Bomb dispensers will be obtained from the Cessna Aircraft Co. for $2,350,000 and a $2,333,080 contract with Talley Industries, Inc., will procure projectiles. Polan Industries, Inc., received a $2,256,000 modification for truck-mounted mine-detecting sets.

General Instrument, Inc., will receive $2,253,600 for fuze assemblies and Poloron Products won a $2,176,000 contract for bomb fin assemblies. American Cystoscope Makers, Inc., was awarded a $2,141,532 contract for telescopes with mounts and spare parts for reconnaissance airborne assault vehicles.

Elliott Machine Works will produce trailer-mounter lubrication and servicing units on a $2,123,199 modification. Southwest Truck Body Co. received a $2,104,321 contract for 6-ton semitrailers and Stewart Warner Corp. was issued a $2,062,830 modification for mortar projectiles.

A $2,074,247 modification to Baldwin Electronics, Inc., is for fuze and switch assemblies for the tactical fighter dispensing system. Pace Corp. will furnish M49A1 surface trip flares on a $1,968,062 modification.

Other contracts and modifications are: Standard Container Co., $1,865,500 for ammunition box assemblies; Fusion Rubbermaid Corp., $1,835,044 for plastic canisters for the tactical fighting dispensing munitions program; Philco-Ford Corp., $1,786,647 for signal convertors for the Shillelagh missile system; Mack Corp., $1,748,560 for 11 line items for the 10-ton truck; and

Polarad Electronics Corp., $1,743,000 for signal generators; Boeing Co. $1,734,650 for modification kits for CH-47 helicopters; Plymouth Plastic Division of AMETEK, Inc., $1,656,000 for support assemblies for fiber ammunition containers; and

Cadillac Gage Co., $1,632,000 for light armored cars; Canadian Commercial Corp., $1,589,250 components of the AN/ASN-64 Doppler navigation set; Alcan Aluminum Corp., $1,480,500 for rocket motors for light antitank weapons;

Temco, Inc., $1,411,410 for metal parts for 106mm projectiles; Sprague Electric Co., $1,312,500, and Westinghouse Electric Corp., $1,282,500 for integrated circuits for fuzes; and

Batesville Manufacturing Co., $1,278,328 for nose fuzes for bombs; Kaiser Aluminum and Chemical Sales, Inc., $1,269,625 for fin assemblies for 81mm mortars; Baifield Industries, Inc., $2,681,280 as the second increment to a $6,271,113 contract for 155mm cartridge cases; and

American Bosch Arma Corp., $1,241,421 for fuel metering pumps for trucks; Servell, Inc., $1,198,500 for dry batteries for radios; Kennedy Van Saun, $1,165,650 for 60mm projectiles; Airport Machine Co., $1,156,250 for mortar projectiles; Midvale-Heppenstall Co., $1,153,425 for tube forgings for guns; and

Atlantic Research Corp., $1,137,902 for explosives; Harnischfeger Corp., $1,127,088 for 20-ton cranes; Stelma, Inc., $1,110,984 for terminal telephones; White Motor Corp., $1,093,860 for cylinder heads for 2½-ton trucks; Portable Electric Tools, Inc., $1,016,015 for fin assemblies for illuminating projectiles; and Sylvania Electric Products, Inc., $1,000,000 for electronic equipment.

TECOM Names Col Goodwin Chief of Staff

Col David B. Goodwin has been assigned as chief of staff, U.S. Army Test and Evaluation Command (USATECOM), Aberdeen Proving Ground, Md., to succeed Col Ralph J. Hanchin, now the chief of the Management Science and Data Systems Office.

Col Goodwin was assigned to the Enlisted Personnel Directorate, Office of Personnel Operations in Washington, D.C., serving since 1963 in various key positions and for the past year as deputy director.

Col D. B. Goodwin

A 1939 graduate of the U.S. Military Academy, he served with the 4th Infantry Division at Camp Gordon, Ga., and in the European Theater of Operations during World War II.

Postwar assignments include commanding officer, 107th Counter Intelligence Corps Detachment, Boston; CO, 18th Mechanized Cavalry Reconnaissance Squadron, Puerto Rico; CO, Student Regiment, Armor School, Fort Knox, Ky.; CO, Support Command, 4th Armored Division, Europe.

Col Goodwin holds the Bronze Star Medal with Oak Leaf Cluster and the Croix de Guerre with Palm. He is a graduate of the Command and General Staff College and Army War College.

COASTAL ENGINEERING RESEARCH

By Albert C. Rayner, Special Assistant
U.S. Army Coastal Engineering Research Center

NOTE: This is the third of a series of articles started in the July-August edition on the Army Corps of Engineers R&D activities.

Devising effective means of preventing erosion of U.S. coastal and lake shores due to waves and currents, through techniques produced by R&D and by improving designs of hurricane protection and navigation projects, is the mission of the Coastal Engineering Research Center, Washington, D.C.

Charged with nationwide responsibility in this vital phase of the U.S. Army Corps of Engineers billion-dollar-a-year civil works program, the CERC is located on the Dalecarlia Reservation in the District of Columbia.

Principal research facilities of the center are a large wave tank, the shore processes test basin, and four smaller wave tanks each designed for specific test purposes.

U.S. Government interest in shore protection was recognized in 1930 when the Beach Erosion Board was established. That agency conducted research on shore processes until it was abolished in 1963. The Coastal Engineering Research Center, its successor, has a broader mission.

The center's large wave tank is of concrete construction, 635 feet long, 15 feet wide and 20 feet deep. Figure 1 shows 6-foot waves in the tank. The wave-generating mechanism, shown in Figure 2, consists of a vertical bulkhead, 15 feet wide and 23 feet high, mounted on a carriage. A continuous range of wave periods between 2.6 and 24.8 seconds can be produced. The maximum usable wave height is approximately six feet.

The shore-processes test basin is an outdoor, rectangular concrete tank with 50-foot triangular sections omitted on two corners. It is 150 feet wide, 300 feet long and 3 feet deep. Movable wave generators of the push-pull bulkhead type, nine with bulkhead face widths of 20 feet and one with a width of 15 feet, are available.

FIGURE 1. Six-foot waves in 635-foot tank at the U.S. Army Coastal Engineering Research Center (CERC).

Machines used in the basin give a continuous range of wave heights up to about 8 inches, with a period range of 0.8 to 4.0 seconds in 2 1/2 feet of water.

The research program at CERC attacks problems related to coastal processes and protection on a broad front. Some of the development studies are made in the laboratory, some in the field; and others are strictly analytical. Facilities of the Corps of Engineers Waterways Experiment Station, Vicksburg, Miss., are also utilized. Some work is contracted to educational institutions. The U.S. Lake Survey District of the Corps of Engineers also has a coastal engineering research program for the Great Lakes which is closely coordinated with the CERC program. This will be discussed in a later article in this series on Corps of Engineers R&D activities.

Wave Action in Coastal Waters. The purpose of wave action research is to gain an improved understanding of the characteristics of ocean surface waves — their generation, propagation, transformation, breaking and action — to enable a more accurate assessment of the effects of waves on coastal structures. Research has led to a complete revision of wave forecasting methods since 1946.

The alignment of beaches and the proper positioning of shore structures and coastal harbor works are closely related to the changes in wave crest alignment and wave height brought about by refraction and diffraction. Intensive efforts at CERC have advanced our knowledge of these phenomena so that diagrams of refraction and diffraction can be drawn up with reasonable confidence, even for rather complex natural conditions.

A reliable estimation of wave forces on piling is often needed by the coastal engineer. A significant contribution in this field is the set of large-scale measurements made under controlled conditions in the large wave tank with waves up to six feet in height.

Shore Processes. Shore processes research is aimed at an improved understanding of the interaction of the natural shore with the forces (waves, wind, tide, current, and surge) imposed upon it.

The manner in which waves dislodge sand from the shoreface and transport the material offshore or along the beach determines whether an erosion-control plan, particularly those including groins, will be successful. Laboratory and field research has resulted in development of a relationship used by engineers today to relate rate of littoral drift to incident-wave energy.

Infrequent occurrence of major storms and hurricanes justifies, in many cases, the use of only sand dikes or dunes to withstand the onslaught of the storm wave. Laboratory studies, coupled with field observations, have enabled establishment of the rate at which sand dikes or dunes will be destroyed by storm-wave action. These studies have resulted in proper selection of cross-sections for hurricane protection dikes.

Figure 2. Wave-generating mechanism for 635-foot tank at U.S. Army CERC.

The loss of barrier islands to storm waves frequently follows decay of the island dunes. Restoration of the dunes by sand fences has been the subject of extensive experimentation. Results have demonstrated effective methods of installing sand fences for this purpose which are being widely used by the Corps, the National Park Service, and State agencies. These studies are being expanded to investigate the use of vegetation for dune restoration and control.

Tides and Surges. This study is giving a better understanding of the characteristics of long waves, particularly tides, storm or hurricane surges, and tsunamis. Involvement of the U.S. Government in hurricane protection in the middle 1950s made it necessary to develop methods of computing hurricane surge heights. Criteria for estimating these effects, developed under the program, are used widely in estimating surge heights in hurricane protection projects.

Inlet and Estuary Dynamics. The Beach Erosion Board recognized before 1950 that the best solution to inlet shoaling and downcoast erosion problems would involve the by-passing of the sand being moved by wave action.

Observations of the only then-existing by-passing plant in the U.S. led to development of general principles for design of by-passing arrangements. As a result, the BEB and CERC have been involved since 1950 in the design of all

A. C. RAYNOR is a civil engineering graduate of the University of Pennsylvania. His career with the Corps of Engineers started in the Philadelphia District of the Corps and he worked in the New England Division for nine years. With the Beach Erosion Board, he served as chief, Project Development Division, from 1946 until the Board was abolished in November 1963. He is now special assistant to the director Army Coastal Engineering Research Center.

by-passing arrangements in the U.S.

The most recent developments for the dual purposes of inlet stabilization and improvement, and sand by-passing, are at Masonboro Inlet and Carolina Beach Inlet, both in North Carolina. In the former case, a jetty completed in 1966 includes a weir section over which sand passes into a deposition basin. The intent is to trap sand in the basin and thus keep it from shoaling the navigation channel. The trapped sand will be periodically removed and transferred across the inlet to prevent erosion of the downdrift shore.

In the Carolina Beach Inlet case, a deposition basin was dredged in June 1967 in the throat of the inlet. No stabilization structures are involved. The purpose is to determine whether a deposition basin in the throat of an inlet can reduce shoaling of the outer bar, or increase the channel depth over that bar. The deposition basin will be dredged periodically to supply material to the downdrift shore.

Design of Coastal Works. Understanding of physical processes and forces will permit improved functional and structural design of all types of coastal works.

Until the mid-1940s, the generally accepted plan for restoring and protecting eroded beaches was to install groin fields of various designs. Hundreds of thousands of dollars were being spent annually by states, cities and private owners on such installations.

Research led to the conclusion that the more successful and more economical solution usually would be the restoration of the shore by placing additional sand on the eroded beaches and resupplying the sand at regular intervals. These findings have been utilized with great success in this country, and have even been acknowledged as correct and adopted in experienced maritime countries such as the Netherlands.

Design criteria for stability of rubble-mound structures in the surf zone have been studied in CERC's large wave tank with breakers up to seven feet in height. This research has furnished criteria for stability which are widely used by the Corps and others in such designs.

The economic justification of many projects depends on the expected life (or cost of maintenance) of the materials of construction. Extensive field observations, coupled with a detailed study of available literature, permitted better estimates of the expected life of steel, concrete, and wood under various conditions of exposure in coastal waters. Recently initiated are additional studies of protective coatings to increase life of steel in coastal structures.

Coastal Construction Techniques. Research in this area provides data on techniques utilized in the construction and maintenance of coastal works. In recent years increasing difficulties have been encountered in locating suitable sand for beach restoration and nourishment. Former land and lagoon sources have frequently become unusable because of high costs or expected adverse effects of dredging on fish and wildlife resources.

As increasing use of offshore sources may be necessary to meet future needs, the Corps has been developing and modifying plants and equipment to pump the sand ashore. In the spring of 1966 the activities culminated in a full-scale trial at Sea Girt, N.J. when some 300,000 cubic yards of sand were pumped ashore from an offshore sand deposit in about 50 feet of water. The sand was pumped through a submerged pipeline by the dredge which had first dredged the sand to fill its hoppers. The procedure promises to reduce greatly the unit cost of placing sand to widen and stabilize beaches, thereby making practical many shore protection projects which otherwise would be prohibitively expensive.

Environmental Data Collection. This program is providing a better understanding of environmental factors related to shore processes and coastal works. The program has three principal parts:

- Regional Studies: Available data concerning geomorphology, including historical shore line positions, littoral materials, and littoral forces of a given region, are compiled, interpreted and published.
- Inventory Investigation of Offshore Sand Deposits: Field investigations have been initiated to determine if suitable and economic deposits of sand adequate for restoration and nourishment of beaches exist in the sea-bottom strata.
- Wave Data: This program provides for installation and operation of wave-gaging stations on all U.S. coasts. Gages are located at Atlantic City, N.J.; Virginia Beach, Va.; Nags Head, N.C.; Daytona Beach, Lake Worth, and Naples, Fla.; Galveston, Texas; Huntington Beach, Venice, and Point Conception, Calif.

Hindcasts of wave statistics from weather data have been made and published for the North Atlantic, Gulf and Pacific coasts, and for Lakes Michigan, Erie and Ontario. Hindcast data are currently being obtained for Lakes Superior and Huron.

Coastal Works Evaluation. A continuing study of all types of coastal works is maintained to evaluate performance.

Coastal engineering is an important part of the nation's oceanographic program. Comprising the physical oceanography of the near-shore area, it contributes substantially to the overall program.

Although shore processes have been understood in a general qualitative way for some years, continued efforts are necessary to quantify the intricate relations between the energy applied to the shore and its reaction to that applied energy, so that protective measures and coastal improvements may be designed with more assurance.

This objective requires detailed study of the many items, some seemingly unrelated, described in this article. Through continued efforts we look forward to the day when we will be able to estimate more accurately rates of shore change, requirements for achieving shore stability, and shoaling rates of inlets and harbors.

As CERC is the U.S. Government agency with responsibility in the field of research in coastal engineering, the CERC program is of great importance to the overall effort. Results of the program are published for the benefit of all concerned with this field of engineering.

Van Sandt Takes Command Of STRATCOM-CONUS

STRATCOM-CONUS has announced assignment of Col William A. Van Sandt as its new commander. Until reassigned recently, he was chief, Signal Branch, Officer Personnel Directorate, HQ Department of the Army.

The U.S. Army Strategic Communications Command for the Continental United States has the basic mission of installing, operating and maintaining the Army portion of the Defense Communications System facilities in the Continental United States and elsewhere as directed.

Col Van Sandt entered the military service in 1941 and is a graduate of the Advances Signal School, the Command and General Staff College, and Industrial College of the Armed Forces.

MUCOM Lists R&D Needs

(Continued from page 6)

OACSFOR; Brig Gen Meetze (USA, Ret.), former deputy CG, MUCOM; Brig Gen Leon Hirshorn (USA, Ret.), CG, Army Ammunition Procurement and Supply Agency; Brig Gen Clifford Sayre (USA, Ret., former deputy CG, Army Chemical Materiel Command); and

Brig Gen William W. Stone, reassigned recently from CG of Edgewood (Md.) Arsenal to the Army Materiel Command as deputy to the Deputy for Research and Laboratories; Robert L. Walsh, NSIA director of committees; Paul Newman, NSIA deputy for special events; and Col Irving R. Mollen, director, RD&E Directorate, MUCOM.

Army Exceeds Cost Reduction Goal

Savings totaling $247.26 million exceeded the Department of the Army Cost reduction Program goal of $224 million for FY 1967 by 10.3 percent. Economies were achieved in 30 areas of effort, the annual report reveals.

New reporting procedures established by DA Circular 11-10 (Nov. 17, 1966) compute estimated savings of cost-reduction actions over a 3-year period (Current, Budget and Future Budget years). Thus, combined 1967-69 savings estimated at $482.78 million are 28.8 percent over the 3-year goal.

In some instances, however, only savings for the current fiscal year are reported, depending on the nature of the cost-reduction activity.

Value engineering (VE) elimination of "goldplating," monitored by the Office of the Chief of Research and Development (OCRD), achieved FY 1967 economies of $78.2 million, 77 percent of the assigned goal of $102 million. For the FY 1967-1969 period, however, the VE projection is 128 percent of the assigned goal for a total of $181.86 million.

The Army received 709 VE Change Proposals (VECP) from contractors during FY 1967 and the U.S. Government's share of savings through approved VECPs was $13.94 million. OCRD reported the approval rate of VECPs acted upon by various Army elements was 52 percent.

In-house elimination of "goldplating" under the VE-Cost Reduction Program included these examples selected randomly from the annual report: (All VE figures are for FYs 1967-1969.)

Watervliet (N.Y.) Arsenal eliminated chrome plating for the 175mm M113 gun tubes (up to 500-round full-charge effectiveness), saving $1.7 million.

The etched-foil tantulum capacitors on multiplexer radio sets (AN/TCC-45 and 46) at the U.S. Army Electronics Command (ECOM), Fort Monmouth, N.J., were replaced by Raytheon Co., with sintered slug tantulum capacitors to save $1.3 million.

Frankford Arsenal, Philadelphia, Pa., saved $4.6 million by issuing an Industrial Technical Data Package permitting a shortened heat-treat process and the use of other heating media on the XM409 projectile body microstructure.

A VE study on maintenance aspects of the Pershing missile at the U.S. Army Missile Command, Redstone Arsenal, Ala., saved $5.98 million. It established a highly skilled technical repair capability, including concentration of repair parts, at general support level and gave guidance and controls sections to depots.

Previously reported in the *Army R&D Newsmagazine* but considered a "classic" in the Cost Reduction Program is the replacement of a $56.80 universal rifle assembly for securing rifles to vehicles with a rifle-bracket kit costing $3.72 each. This accomplishment at the Army Tank Automotive Command, Warren, Mich., saved $2.96 million.

Other relatively small items of Army cost-reduction efforts are evidence of the coordinated efforts of various Army agencies and the ingenuity of military and civilian employes in solving problems or innovating improvements.

By consolidating multiyear requirements into one contract for a signal generator which provides voltage for testing electronic equipment, ECOM saved $401,556 on a $3.4 million procurement for FYs 1967-1968.

Industrial engineers at the U.S. Army Quartermaster Center, Continental Army Command, Fort Monroe, Va., centralized four supply rooms which had been serving four maintenance shops. The consolidated activity reduced total line items from 4,000 to 600, decreased the inventory 85 percent and saved $18,000 in FY 1967.

Through competitive procurement, the Army Aviation Materiel Command, St. Louis, Mo., saved $36,404.40 in FY 67 on rotor-engine warning boxes for aircraft. A flat $160.29 previously had been paid for each unit; they now cost $139.29 each.

With "no lowering of standards of security," the Satellite Communications Ground Terminal at Camp Roberts, Calif., replaced gate guards (annual salary $17,820) with an automatically opening gate in response to a vehicle control device (installed cost $5,675) for 3-year savings of $47,785.

Hawk Restoration Program Saves $30,000 per Missile

Rebuilding of environmental or age-deteriorated "unreliable" Hawk air defense missiles entered the Cost Reduction Program in FY 1967 with a saving of $30,000 for each missile "rehabilitated."

Deployed in the field for the past seven years, Hawk batteries around the world are manned by special units of the U.S. Army, Marine Corps, and MAP (Military Assistance Program).

A testing program at White Sands (N. Mex.) Missile Range supports the three rebuilding facilities at Letterkenny Army Depot, Pa., Red River Arsenal, Tex., and Pueblo (Colo.) Army Depot.

In the rebuilding program, each unfired missile ($35,000) is returned to the states after a prescribed "shelf period" determined by service-life tests at White Sands. Restoration of one missile costs $5,000.

USMA Reports Uplifting Savings On Elevator Maintenance Costs

The U.S. Military Academy (USMA), West Point, N.Y., has 41 elevators each of which used to cost $1,138.56 per year (total $46,681) to keep in operation.

Probably to the chagrin of the maintenance contractor, someone figured that all 41 of the lifts were not always in use and demanded a survey, a classification of elevators by "use categories."

An elevator-by-elevator check determined actual hours of operation and the "flat rate" was deleted from the contract. The scaled-down maintenance reduced the cost per year per elevator to $902.93. FY 1967 savings were $9,660.83 — a tidy sum destined to continue.

Air Force Medic Heads Radiobiology Institute

Command of the Armed Forces Radiobiology Research Institute (AFRRI) changed recently when Col Hugh B. Mitchell, U.S. Air Force Medical Corps, succeeded Capt Joseph S. Burkle, U.S. Navy Medical Corps, as director.

Capt Burkle retired from the U.S. Navy after 24 years of service and was awarded the Legion of Merit for outstanding service at the institute since June 1966.

A tri-service command of the Defense Atomic Support Agency (DASA), AFRRI was created six years ago to investigate the effects of ionizing radiation on biological systems. Col James T. Brennan, U.S. Army Medical Corps, was the first director.

'The institute currently uses a TRIGA Mark F nuclear reactor as its principal source of radiation for experiments. Scheduled for operation in the spring of 1968 is an electron linear accelerator (LINAC) that will have expanded capabilities over about 75 LINACS installed throughout the world.

Col Hugh B. Mitchell

Col Mitchell has an MD degree from Louisiana State University and a master's degree in bioradiology from the University of California at Berkeley. His medical experience includes private medical practice and tours of duty in U.S. Navy and U.S. Air Force hospitals throughout the country. In 1959 he was chief, Bionucleonics Section, Office of the Surgeon, HQ Strategic Air Command.

He joined AFRRI as assistant deputy director, scientific, in 1965. In addition to duties at AFRRI, he served as surgeon and chief, Medical Directorate, DASA headquarters Nov. 1, 1966 to Aug. 1, 1967.

Col Mitchell is a member of the American Medical Association, Aerospace Medical Association, Association of Military Surgeons, Health Physics Society, Society of Nuclear Medicine, Radiation Research Society, and the Society of USAF Flight Surgeons.

Report Outlines 20-Year Program to Alleviate World Food Problem

NOTE: Publication of this article is believed of interest to the Army R&D community because of the very extensive R&D activities of the Army, particularly the numerous studies made by the U.S. Army Medical Research and Nutrition Center, and Fitzsimons General Hospital, on nutritional requirements, food preservation and packaging, and food problems in underdeveloped countries.

Volume 3 of "The World Food Problem," prepared by a special panel of the President's Science Advisory Committee, is scheduled for distribution late this month. It reports on a 20-year program to alleviate the problem, involving a broad R&D effort, at a rough estimate cost of $12 billion.

In a Message on Food for Freedom, Feb. 10, 1966, President Johnson instructed the Science Advisory Committee to search out new ways to develop inexpensive, high-quality synthetic foods as dietary supplements; improve the quality and nutritional content of food crops; and apply all of the resourses of technology to increasing food production.

Based on a year of study, the special panel concluded that "the scale, severity and duration of the world food problem are so great that a massive, long-range innovative effort will be required to master it."

More than 100 experts and consultants drawn from the government, universities, foundations and industry participated in the study by serving on 13 subpanels. Dr. Ivan L. Bennett Jr., deputy director, Office of Science and Technology, was chairman and Dr. H. F. Robinson, administrative dean for reasearch at the University of North Carolina, was executive director.

The $12 billion cost estimate, Dr. Bennett stated, is for "additional capital investment in the developing countries over the next 20 years. . . .Much of the investment will be by the countries concerned."

Since the first two volumes of the panel report were distributed in June, he said, they have drawn wide attention in both developed and developing countries. The report forecasts that overall food requirements will rise by 50 percent within 20 years, and need in developing countries will double. It warns against the false hope that some panacea will appear as an answer to food shortages.

Publicity given to various food synthesis problems is decried in the report as lessening public concern about the seriousness of the situation. Strong support of R&D of such processes must be continued, it states, but points out that usefulness will take years to determine because of technical problems, questions of processing costs, and consumer acceptability.

The second chapter of the first volume states: "This report, which we had originally hoped would be a blueprint that would enable the United States to translate its concern into action, is more of a sketch than a set of working drawings. Our greatest difficulty has been to offer a descriptive analysis which avoids undue emphasis upon single elements of a complex problem."

While recommending support of voluntary programs of family planning for developing countries, the panel cautioned that this alone will not significantly reduce the food problem within the next 20 years. Population in developing countries will increase rapidly because nearly half of the people are under 15 years old.

Improvement in agricultural methods within the developing countries themselves is stressed as the main source of food during the next 20 years. The report states they "must establish agricultural development as a national goal, with relevant research, education and extension programs" to adapt plant and animal production to meet nutritional needs."

More than two-thirds of the human race is involved in the declining condition of the food supply with respect to the population explosion, the report observes.

One of its conclusions is that "the entire foreign assistance effort of the United States in concert with other developed countries, voluntary institutions, and international organizations" must be used to attack the problem, including private industry support.

Pleading for abandonment of the "know-how, show-how" idea of help for agriculture in developing countries, the report states that agricultural technologies are not directly transferable to different soils and climates. It stresses the necessity for adaptive research in devising agricultural systems for each region of the world, saying:

"There is an urgent need to carry out the self-sustaining, continuing programs of research and development that are essential to modern food production."

It notes that the most needed resource in the developing countries is scientific, technical and managerial skill for decision making and implementation.

It recommends that technical assistance programs emphasize guidance, education and the development of indigenous capabilities, and that the United States Government and universities develop policies and programs to carry out long-term commitments for overseas research and educational assistance.

"The universities of the United States must be encouraged to develop competence among their faculties, construct the necessary facilities, and develop their curricula in ways that will enable them to better participate in international education and research of importance in population control, food and nutrition of developing nations.

"Long-range financial commitments, staffing and program orientation are necessary at the United States universities to accomplish this objective. Funds should be provided for use in research and training in nutrition and the agricultural sciences in order that future manpower requirements may be met."

The report recommends a long-term bilateral foreign aid program for humanitarian, diplomatic, economic and security reasons.

It quotes Secretary of Defence Robert S. McNamara's speech in Montreal in 1966:

"Our security is related directly to the security of the newly developing world. In a modernizing society, security is not military force — though it may involve it. Security is not traditional military activity — though it may encompass it. Security is development."

ECOM Plans Meteorological Meet

Arrangements are being made for the U.S. Army Atmospheric Laboratory, Electronics Command, Fort Monmouth, N.J., to act as host to a multiagency technical exchange conference in April 1968.

The conference series was initiated in 1965 by the Air Weather Service (AWS) of the U.S. Air Force, Scott AFB, Ill. AWS CG Brig Gen Russell K. Pierce Jr. extended the invitation accepted by ECOM CG Maj Gen William B. Latta.

The meetings bring together military and civilian scientists to discuss specific forecasting problems in operational meteorology. Participants have included the Army, Navy, U.S. Weather Bureau, Federal Aviation Agency and invited meteorologists.

Meara Heads TECOM's Test Analysis, Operations Office

Col William D. Meara, new chief of the U.S. Army Test and Evaluation Command's Test Analysis and Operations Office at Aberdeen Proving Ground, Md., was until recently G-3 of the Army Combat Developments Command Experimentation Center, Fort Ord, Calif.

From 1961 to 1964, he was in Germany with the Military Assistance Advisory Group, following three years at Fort Hood, Tex., where he commanded medium tank battalions.

Col Meara is responsible for shaping TECOM's policies, procedures and regulations for testing and evaluating military hardware. His office reviews and analyzes tests reports and plans test programs conducted by 15 proving grounds, service test boards, and experimental test centers.

Col William D. Meara

Natick Pamphlet Details Vietnam Support

Developmental response of the U.S. Army Natick (Mass.) Laboratories to many urgent operational requirements for the Vietnam War is detailed in a recently issued U.S. Army Materiel Command pamphlet.

Modern warfare with all its sophisticated weaponry has not altered the centuries-old fact that to win wars vital ground must be gained and held by foot soldiers who often must slog through mud, rain, heat or cold to seize an objective. That puts emphasis on special boots for special needs.

"Support to United States Army in Vietnam" therefore opens naturally on development of various types of footwear, such as: tropical combat boot, direct molded sole; special boot for Thai and Vietnamese soldiers; tropical combat boot, spike-protective; tropical combat boot, blast-protective; and overboot, blast-protective.

An experimental tropical combat boot dating back to 1955 failed to satisfy the continuous wetting and drying of the jungle environment of Vietnam. The stitching deteriorated rapidly, often in four to five weeks.

To overcome this difficulty, the direct molded sole was developed by the Natick Laboratories. Adopted for the Army and the Marine Corps in 1965, the new boot has been supplied to Southeast Asia in more than 2,000,000 pairs.

In January 1967, the Army converted its all-leather combat boot to the direct molded sole construction.

Boots developed for the typical American soldier, however, are not generally suitable for the Vietnamese soldier because of differences in size and conformation of feet. Based on anthropometric studies of Thai and Vietnamese soldiers and previous research conducted on the U.S. Military V last, a new boot last was developed for their use. A Natick footwear technologist went to Vietnam to assist in setting up manufacturing facilities.

DMS BOOT with integral, spike-resistant insole protects against poisoned punji stakes and spikes used by Viet Cong.

Hidden, poisoned punji stakes and other contaminated spikes which easily penetrated the boots used in Southeast Asia presented a serious problem as early as 1961. A slip-in protective insole was developed, consisting of a layer of .011-inch stainless steel with a permanently cemented layer of Saron for ventilation.

Complaints were received from Vietnam late in 1965 that the insole was causing blisters and problems in fitting. In response, the Natick Laboratories modified the Direct Molded Sole Boot to make the steel spike shield an integral part by inserting it between two layers of leather. This change overcame both causes of complaint and the boots are now being supplied in quantity.

Antipersonnel-type mines in the Korean War caused a substantial number of foot and leg amputations which led to an extended research program by the Natick Laboratories in conjunction with the Office of The Surgeon General to develop a protective boot.

The solution was to alter the DMS tropical Combat Boot by incorporating a stainless steel wedge (investment cast) filled with aluminum honeycomb and covered on the top with aluminum plate. The protective shank weighs seven ounces. Initial deliveries are planned this fall.

Research data gained during evaluation of the Blast-Protective Boot led to development of an overboot. It was found that the overboot increases the potential "save" of the foot from 45 to 90 percent, and also offers protection to the bony structure of the lower leg. The boot is being tested in Southeast Asia for comfort and wear characteristics.

Jungle conditions in Southeast Asia have required development of a variety of special clothing items — tropical camouflage uniforms; three types of trouser-jacket rainsuits; a lightweight tropical combat uniform and a hat with a detachable headnet; a yard-square neckerchief used to wipe persperation and mud from the face, neck and hands; and a new water-repellent, lightweight, camouflage, general-purpose poncho and ground cloth.

Evaluation reports from the U.S. Army Test and Evaluation Command indicate that a new skin camouflage paint developed for a variety of environmental conditions is satisfying tests. The improved product is easy to apply even after aging, contains the most efficient insect repellent known, and is relatively odorless for security of the wearer. It comes in shades for tropical jungle, desert or snow areas.

Another new item developed for use in Vietnam is a 2-quart collapsible canteen that does not rattle, is highly resistant to puncture or tearing (made of ethylene-vinyl-acetate copolymer with a nylon duck cover), and has a pocket for water purification tablets and a collapsible container for boiling water.

Tested extensively and found superior to equipment now in service is a new lightweight jungle rucksack with a frame of spring steel. The fabric and webbing are of nylon treated for water repellency and rapid drying, instead of the cotton materials used in the M-56. The rucksack has more capacity than the standard item and is made without projections to eliminate snagging in underbrush. Expendable

JUNGLE RUCKSACK is lighter, can carry more, and has no projections to "hang-up" on Vietnam jungle growth.

M-79 GRENADE CARRIER provides 18-round capacity and one-handed capability for extraction of round.

water-proof plastic bags shield each outside-pocket and the main pouch.

Lightweight, experimental load-carrying equipment was shipped to Vietnam this year for further evaluation. Tests have proved it is more functional than the standard M-56 item and is more comfortable for carrying.

Soldiers in Vietnam are evaluating a new vest carrier for the M-79 grenade which has an 18-round capacity, provides secure carrying for all rounds, is designed for one-handed extraction of a single round magazine for the 5.56mm M-16 and ing. The vest is fabricated from a nylon netting to minimize heat stress and is adjustable at either side.

Ammunition pouches for the new 30-round magazine for the 5.56mm M-16 and M-16E1 rifle also are being developed as a rapid-response item to a request from Vietnam. The pouch developed by the Natick Laboratories can carry three 30-round magazines, will retain one, two or three magazines when the lid is not closed, eliminates rattling of magazines after removal of one, and permits one-handed opening and closing.

Vietnam operations demonstrated that the standard jungle hammock was too heavy and bulky in combat conditions, leading many soldiers to sleep on the wet ground of the jungle. Following tests of two new types, one of nylon and one of fishnet, an order was placed for procurement of the nylon type. It weights one pound six ounces as compared to three pounds 14 ounces for the standard item.

Under development is a bullet-proof body armor for soldiers similar to that being furnished Army aircrewmen. It will supplement the standard infantry body-armor vest for protection against fragmentation weapons, and be worn over the standard vest or in place of it. Weight will vary from 19 to 24 pounds, depending on small, medium and large sizes.

SAFETY HARNESS provides positive safety of quik-release system to accommodate crewmen and gunners.

BULLET-PROOF body armor protects the soldier from small arms fire. Weight ranges from 19 to 24 pounds per unit.

Lightweight felt body armor vests also are being tested and evaluated in Vietnam by the 1st Infantry Division. Intended to be worn in place of the standard 8.5-pound fragmentation protective vest, the felt model is of nylon one-third inch thick.

Three panels of felt form the basic vest filler, made of polyethylene to prevent absorption of moisture. Four additional piles of ballistic protective nylon protect the heart and spine areas. The medium-size vest weighs four pounds eight ounces.

Small arms protective body armor for aircrewmen was developed by the Natick Laboratories in response to a Vietnam requirement directive in May 1966. Within a period of one year, three types of armor to protect the torso, thighs and legs were designed and ordered for large-scale procurement. As the report was prepared, about 18,000 of the armor items had been supplied to Southeast Asia.

New also for aircrewmen on duty in Vietnam are experimental flame-resistant uniforms still being evaluated under field conditions, a ballistic-resistant crash helmet that provides significantly improved protection (12,475 shipped recently), a retention harness still under development, a glareshield for helmets, and a shatter-resistant eyeshield.

The Low-Altitude Parachute Extraction System (LAPES) introduced by the U.S. Air Force in 1963 was tested by the U.S. Army Test and Evaluation Command as a supplementary method of aerial resupply (loads ranging from 3,780 to 14,000 pounds). Although the system has not been adopted for Army use, the Natick Laboratories are obtaining a limited supply.

Improvement of the G-13 cargo parachute, including a rider extension suitable for the Vietnam jungle, has progressed through various test phases and evaluation is expected to be completed in the near future.

The Natick Laboratories also are making additional improvements on a troopers' ladder for lowering or retrieving troops from a CH-47 helicopter in areas where it cannot land. The request was received from the 1st Cavalry Division in August 1965. Delivery of about 160 kits of a substantially improved model began in October 1966 and was completed in March 1967. This satisfied the immediate requirement until further refinements can be made.

The U.S. Army Limited War Laboratory (LWL), Aberdeen Proving Ground, Md., was given the task of designing a simple lightweight means of lowering cargo and individuals from hovering helicopters to areas unsuitable for landing. The resultant Personnel/Cargo Lowering System and Interim Floor Anchoring Device has been successfully service tested and a quantity delivered to Vietnam under a Quick Reaction Procurement.

Three Fulton Retrieval System (Skyhook) units under development by the U.S. Air Force were procured by NLABS for evaluation to retrieve personnel from the ground by CV-2 Caribou airlift during the day or night. If eventually accepted, the system will give the Army a new capability.

An individual lightweight survival kit for aircrewmen developed by NLABS in response to a July 1966 request was delivered to the Aviation Test Center, Fort Rucker, Ala., for service test in April 1967. Results were satisfactory and delivery of the kit to Vietnam was started that same month.

Evaluation of a Crewman/Gunners Safety Harness for use in the CH-47 and HU-1B helicopters is scheduled to begin this month (October) in Vietnam. The harness was developed as a rapid-response item to provide positive safety of

(Continued on page 28)

PERSONNEL/CARGO device lowers equipped trooper from hovering helicopter to area unsuitable for landing.

Dr. Larsen Discusses R&D for Vietnam Needs

Dr. Finn J. Larsen, Principal Deputy Director of Defense Research and Engineering, discussed R&D successes, shortcomings and the job ahead in Southeast Asia as the banquet speaker Sept. 19 at an advanced planning briefing for industry.

Attended by about 800 industrial and Federal Government representatives, the briefing in Washington, D.C., was sponsored by the U.S. Army Munitions Command in affiliation with the National Security Industrial Association (NSIA). A condensation of his address follows:

". . .I will describe our overall program for (1) R&D Support of the War in Southeast Asia, (2) Tactical Warfare Capabilities, and (3) The Defense Research and Technology Base.

"On the first of these, the RDT&E support to operations in Southeast Asia, there are three points I want to emphasize. First, the Vietnam conflict is testing — and testing demandingly — almost all of the tactical (and some of the strategic) military equipment and concepts developed in the last 20 years of R&D.

"Second, we have had great success with comparatively recent combat innovations produced from our R&D efforts. These include the whole airmobile concept, our first-generation of night-vision devices, our new Navy attack and early warning aircraft, the new bomblet munitions, a new generation of combat radios, and many other items of combat and support equipment.

"Third, these tests and innovations, taken together, are revealing a range of inadequacies in our capability to deter and fight limited wars. . . . We have made some significant progress — but still more is required.

"To give you a view of R&D in the war effort, I will use the framework of our objectives in SEA. These are:

"(1) The interdiction campaign against the military potential of the North; the air war dedicated to increasing the cost of sending war materiel South;

"(2) The counter-infiltration effort to impede the flow of men and materials into and throughout SVN — this effort includes the bombing in northern NVN, seacoast activity and river operations;

"(3) The 'search and destroy' mission within South Vietnam (SVN) to destroy enemy military capability and resources — this effort consists of our airmobile and amphibious units and associated close air support; and

"(4) The nation-building program (now called Revolutionary Development) aimed at securing the countryside and establishing the base for indigenous government control of SVN — this work spans the complete range of civic and military activity in Southeast Asia.

"Interdiction. Our efforts to destroy the NVN military materiel before it moves down into SVN have been substantial. These efforts have identified many critical R&D areas. The areas of concern in air operations can be simply categorized:

"Finding the target — for this we need improvements in target acquisition techniques, new night-vision devices, better and faster reconnaissance and bomb-damage assessment, greater night-attack capability, and advanced aircraft to pinpoint the location of enemy radars and antiaircraft weapons.

"Attacking the target — here we need improved weapons and weapon-delivery systems, more accurate missiles, and an improved stand-off missile capability.

"Reducing aircraft attrition in the high-threat environment of NVN — by better techniques for knocking out the missile sites, or protecting our aircraft with improved armor."

(At this point, Dr. Larsen launched into a discussion of electronic warfare, the need for great improvement in combat aircrew recovery from downed aircraft, tactical reconnaissance aircraft systems, counter-infiltration techniques, and search and destroy capability.)

"A crucial area for R&D" he continued, "and one in which I'm afraid we still have much more theory than proven practice — is Revolutionary Development, formerly referred to as 'nation building' or 'pacification.'

"The jobs are clear: understanding the people as well as the enemy, working with other U.S. activities to strengthen the SVN government, and finding means to assist in social and economic development. We have a responsibility and are supporting projects in both the 'hard' and 'soft' sciences. ARPA (Advanced Research Projects Agency) is heavily involved. . . .

Natick Pamphlet Details Vietnam Support

(Continued from page 27)

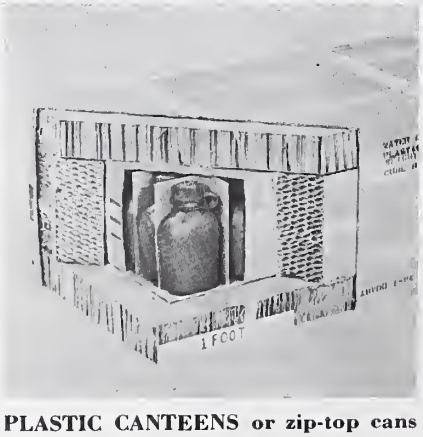
for the quick-release system and adjustment for the shoulder and leg straps to accommodate all size airmen.

Two types of free-fall water containers for airdrop were developed by the U.S. Army Limited War Laboratory and evaluated by NLABS. The 3-gallon unit, fabricated of eight layers of polyurethane packaged in fiberboard boxes to facilitate handling, can be dropped from free fall at 50 to 250 feet at airspeeds up to 130 knots (about 146 m.p.h.) without breaking all eight layers upon ground impact. The other method involves use of honeycomb cardboard to absorb impact and either one-quart plastic canteens or zip-top cans.

Troops subsisting on packaged rations in Vietnam expressed a desire for additional fruit beverages to overcome the undesirable taste of the drinking water. The commanding general of the 1st Logistical Command requested in April 1967 that 100 12-ounce servings of fruit beverage and tea be developed for each 100 rations. This supplement is being provided.

Freeze drying techniques were modified in 1966 to achieve radical improvement of rehydration characteristics of the Long Range Patrol Food Packet, developed by the U.S. Army Limited War Laboratory and approved in December 1963 for limited production.

Important improvements were made also in upgrading the packaging and packing of all commodities destined for Southeast Asia. The new unitized and containerized loads of nonperishable subsistence and combat rations are packed in a V2s material with an additional 3-mil polyethylene shroud. This provides the required protection for open storage in areas of heavy rainfall, high humidity and adverse environmental conditions.



PLASTIC CANTEENS or zip-top cans are rigged inside paperboard rectangular containers with a 3-inch layer of paper honeycomb for air drop delivery.

S.E. Asia Troops to Evaluate New Blast-Protective Boot

Field evaluation of the Army's newest blast-protective tropical combat boot will begin soon with the shipment of 800 pairs to Army and Marine Corps troops in South Vietnam and 100 to the Army in Korea.

U.S. Army Natick (Mass.) Laboratories received the initial shipment of 1,000 pairs in September from the Safety First Shoe Co., Huntsville, Ala. NLABS is retaining 100 pairs of the boot for additional evaluation.

The boot incorporates a stainless steel wedge filled with aluminum boneycomb and covered on the top with aluminum plate. The wedge covers the heel and arch areas and has a V-shaped cross section to deflect the blast upward and outward.

Foot protection against the blast effect of antipersonnel mines is the result of research for the past four years by Natick Laboratories with the Office of The Surgeon General. Attenuators were developed by the IIT Research Institute.

"R&D Coordination. I want to emphasize what we are doing to coordinate and expedite our varied R&D efforts.

"About a year ago we established, in DDR&E, the Deputy Director for Southeast Asia Matters, to deal with SEA items directly.

"We established PROVOST (Priority Research Objectives Vietnam Operational Support) to react on an across-the-board basis (ODDR&E, Military Departments, Joint Chiefs of Staff) to urgent technical-operational problems.

"We have assigned two distinguished defense scientists to act as advisers to Admiral Sharp (CINCPAC) and General Westmoreland (MACV). Dr. W. G. McMillan is in Saigon and Dr. J. S. Lawson is in Hawaii at CINCPAC HQ.

"The Services established 'lead' in-house laboratories to coordinate our national technical resources and apply them to SEA problems.

"The willingness of our able Field Commanders to accept this help, to innovate, and to press the concept of 'Combat RDT&E' has been gratifying to all of us.

"*Immediate Goals.* Some areas which we need to push next year include: better radar; improved accuracy ordnance and bomb delivery systems to reduce the required number of sorties; better stand-off and flak-suppression weapon systems to reduce our aircraft attrition; improvements to our air-to-air missiles and fire control systems, and better IFF equipment for our fighters;

"Better command and control systems by which to direct our war against elusive interdiction and inflitration targets; better capability for search and rescue of downed pilots; continued development of a more versatile electronic warfare capability; better real-time and night-time reconnaissance sensors; better intrusion-detection devices, new surveillance systems, and area attack weapons to counter infiltration into SVN and to enhance our defenses around hamlets, villages and military bases;

"Better defenses against mortar attacks, better detection of ambushes and land mines, and better means of detecting, neutralizing and denying tunnels; better Forward Air Controller aircraft and sensor equipment; better mine detection and swimmer defense systems for use with the 'shallow water Navy'; better cross-country vehicles; better all-weather navigation and ground-directed bomb delivery systems;

"Additional means of reducing helicopter attrition, such as better armor and directional ground-fire detection equipment; increased emphasis on the development of a balanced capability for all our forces to fight at night, offensively as well as defensively;

"Increased ability to produce detailed and timely intelligence on enemy movements and guerrilla activity; better artillery munitions; better and more extensive psychological warfare capability, and a fuller understanding of the guerrilla motivations and aspirations to assist the Revolutionary Development Program."

Dr. Larsen, in discussing longer range, broader tactical warfare programs, cited developmental effort on the Airborne Warning and Control System (AWACS) and the complementary Air Force ground-based Tactical Air Control System (TACS), as well as Navy Tactical Data Systems.

He also mentioned two new aircraft under development — the F-111A and F-111B — and a third under study, the VFAX-FX, as well as work on the WALLEYE, CONDOR and MAVERICK systems to lock a missile onto a target so that the aircraft can leave the target area promptly.

Turning to a discussion of improving land warfare capabilities, Dr. Larsen cited R&D efforts aimed at providing the individual infantryman with "improved sensors to extend his powers of observation, and with greater mobility and firepower.

". . .To provide necessary direct fire support in airmobile operations, we have adopted machineguns and rocket pods to the transport helicopter as a temporary measure. To reach higher-level requirements, we are developing the Advanced Aerial Fire Support System (AAFSS). The first experimental flight tests will start soon."

Dr. Larsen referred also to development of the Lance missile system to replace Honest John and Little John; continued development of the Main Battle Tank (MBT) as a U.S./Federal Republic of Germany joint effort; and the emergence of antitank missile weapons such as Shillelagh, TOW and MAAW.

In concluding with a discussion of the Department of Defense research and technology base to provide the superior U.S. weapon systems of the future, he said:

"The in-house laboratories play a key role. They provide the 'coupling' between what is technically feasible and what is operationally needed, and they carry out much of the applied research, and the exploratory and advanced development. The university laboratories are more involved in basic research to deepen our scientific insights into fundamental problems that impede progress in key areas of defense technology.

"You in industry generally conduct the more ambitious advanced technology and engineering development projects. You also make significant contributions to the research base through a wide-ranging contract effort and through your independent research and development program."

Dual-Purpose Welder Classified Standard A

A lightweight, dual-purpose welder developed by the U.S. Army Mobility Equipment R&D Center at Fort Belvoir, Va., has been classified Standard A by the Army, indicating that it is the most advanced and satisfactory to satisfy current military requirements.

At 780 pounds, the welder weighs 70 percent less than conventional single-purpose units. An entire field-welding shop can be transported by vehicles normally used to carry the conventional generator.

The welder can furnish power for the Metal-Inert Gas (MIG) required for lightweight metals such as aluminum, magnesium and titanium, as well as for conventional covered-electrode welding. It will supply 300 amperes constant-voltage power for the MIG semiautomatic welding process, or 300 amperes constant current for conventional welding.

HumRRO Issues Bibliography On Instructional Systems

Over 400 educational documents are listed in *An Annotated Bibliography on the Design of Instructional Systems* (TR 67-5), a new technical report of the Human Resources Research Office (HumRRO).

Listed with the Defense Documentation Center and with the Clearinghouse for Federal Scientific and Technical Information as AD-653 128, the report is a supplement to HumRRO's *Design of Instructional Systems* (see April 1967 issue of this Newsmagazine), listed as AD-644 054.

The entries are divided into six sections: systems—general, training systems, presentation of knowledge, practice of knowledge, practice of performance, and management of students.

AFIP Names Col Johnston Assistant Pathology Chief

Col Edward H. Johnston, MC, one of the five military physicians certified in forensic pathology, has been named assistant chief of the Department of Pathology, Armed Forces Institute of Pathology.

He succeeds Col James L. Hansen, MC, now deputy director of AFIP.

From August 1964 to May 1966, Col Johnston was chief of the Department of Pathology, USA-SEATO Medical Research Laboratory, Bangkok, Thailand. From 1956 to 1963, he was with AFIP.

In addition to his new duties, Col Johnston will continue as chief of the Aerospace and Toxicology Branches, two of the Pathology Department's 37 speciality branches.

He received his medical degree in 1948 from the University of Pittsburgh and an MS degree from Baylor University. As an undergraduate, he attended Pennsylvania State University and Cornell Univ.

Col Edward H. Johnston

Bearded Men Are Dangerous

Whiskered Microbiologists May Harbor Disease

Bearded laboratory microbiologists who do not give their Vandykes and cheek whiskers a sanitizing shampoo may transmit to their families such diseases as Q or West Nile feaver, tularemia or Venezuelan equine encephalomyelitis.

This is not an epidemic "scare" story, but bearded men have returned to the laboratory scene and scientists at Fort Detrick, Md., have conducted research to evaluate the hypothesis that:

"A bearded man subjects his family and friends to an infectious hazard if his beard is contaminated with infectious microorganisms while he is at work in a microbiological laboratory."

Test-tube sampling techniques were used to recover *Serratia marcescens* organisms and *Bacillus subtilis var niger* spores that had been sprayed onto 73-day-old beards of four volunteers and the shaven faces of five others.

Two time intervals were used: 30 minutes — representing the time to complete an important experimental series despite known accidental contamination of the beard before rejoining associates — and 6 hours, representing the time between an unrecognized contamination and family contact with the unwashed beard.

Organisms used in the experiments were recovered from washed and unwashed beards, from shorn hair before and after washing, and from washed and unwashed clean-shaven faces when microbiological culture-recovery techniques were started 30 minutes after spraying with bacteria. Both species of bacteria were recovered from unwashed beards after six hours.

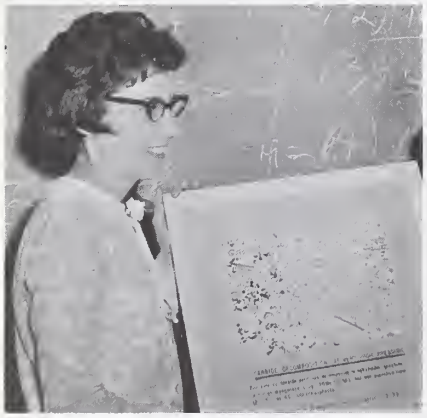
General conclusions, providing the moral to this story are: A beard is more resistant to cleansing than a clean-shaven face, but a microbiologist, with or without beard, should wash thoroughly with an adequate disinfectant before going home for an affectionate greeting from the wife and children.

TECHNIQUES used to recover microorganisms from beards included (top) modified millipore filter holder, aluminum comb fitted with nonabsorbent cotton, Rodac plate; (bottom row) Calgiswab, and physiological saline rinse.

Watervliet Adds Distinguished Metallographer

Feminine scientists who are making a notable contribution to Army research and development have a distinguished addition in Theresa V. Brassard, a metallographer whose work has been recognized by numerous awards.

Mrs. Brassard has joined the staff of the Maggs Research Laboratory at Watervliet (N.Y.) Arsenal and has been assigned to the Physical and Mechanical Metallurgy Laboratory.



WATERVLIET METALLOGRAPHER Theresa V. Brassard displays photomicrograph depicting carbide decomposition results at very high pressure.

Primary responsibility of the attractive metallurgist, whose youthful appearance belies her distinguished scientific career, will be to determine morphologies in gun steels and their relationships to the mechanical properties and behavior of these materials.

Before coming to the Army Weapons Command installation, Mrs. Brassard was on the staff of the General Electric Co., Research and Development Center, Schenectady, N.Y., where her assignments included metallographic structure studies on the formation of man-made diamonds and pyrolytic graphite.

Her photomicrographs have received 25 national and regional awards, including the Blue Ribbon Award presented at the 1966 metallographic exhibit of the American Society for Metals. She has also received "best in class" awards from the American Ceramographic Society, and the American Society for Testing Materials.

Examples of her work are on display in the Smithsonian Institution, California Institute of Technology, the Rochester (N.Y.) Memorial Gallery and the Albany Institute of History and Art.

Army Library Lists New Books on R&D

Among the recent acquisitions of the Army Library, the Pentagon, Washington, D.C., are the following volumes of possible interest to Army research and development personnel.

Adaptive Method of Test Selection in System Development, An, N. H. Hakansson (Rand), Q 180 .A1 R18 no. 5238.

Area Handbook for Saudi Arabia, 1966, Foreign Area Studies of the American University, DS 204 .A67 1966.

Aspects of a Computational Model for Long-Period Water-Wave Propagation, Jan J. Leendertse (Rand), Q 180 .A1 R18 no. 5294.

Atlas of Landforms, James L. Scovel (U.S. Military Academy, West Point, Dept. of Earth, Space and Graphic Sciences), G 1046 .C2 U5 1966.

Avoidance of Thermal Strain, William H. Goesch (NATO/AGARD), TL 500 .N862 no. 547.

Communication and Culture: Readings in the Codes of Human Interaction, Alfred G. Smith, HM 258 .S64.

Cost of Basic Scientific Research in Europe: Department of Defense Experience, 1956-1966, E. D. Brunner (Rand) Q 180 .A1 R18 no. 5275.

Counter-Insurgency Operations: Techniques of Guerrilla Warfare, Julian Paget, U 240 .P13.

Customs and Taboos of Selected Tribes Residing Along the Western Border of the Republic of Vietnam, Skaidrite M. Fallah (CRESS), HN 761 .V6 F19.

Design, Development and Utilization of a General Purpose Airborne Simulator, Donald T. Berry and Dwain A. Deets (NATO/AGARD), TL 500 .N862 no. 529.

Financial Portion of a Management Information System, The, F. S. Pardee (Rand), Q 180 .A1 R18 no. 2836.

Glossary of Contract Management Terms: Secretary of Defense Project 60, Mac C. Wells, HD 19 .W45.

Guidelines in Accumulating Financial Data on Future Weapons, F. S. Pardee (Rand), Q 180 .A1 R18 no. 2583.

Insurgency as a Strategic Problem, Paul Kecskemeti (Rand), Q 180 .A1 R18 no. 5160.

Inventor's Patent Handbook, The, Stacy V. Jones, T 339 .J79.

JOSS: Problem Solving for Engineers, E. P. Gimble (Rand), Q 180 .A1 R18 no. 5322.

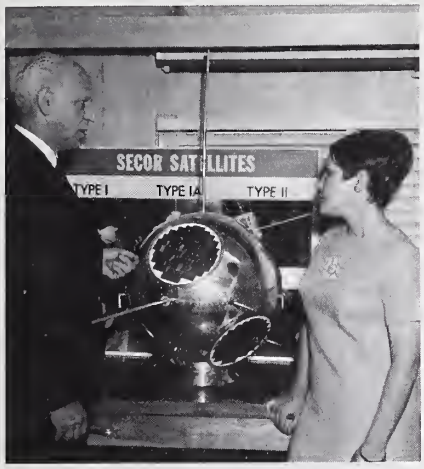
Jungle Acoustics II: Localization of Sounds in the Jungle, D. A. Dobbins and C. M. Kindick (U.S. Army Tropic Test Center), U 167.5 .J8 D628 v.2.

Machine Intelligence, v.1: Proceedings of the Machine Intelligence Workshop, Q 335 .M14 v.1.

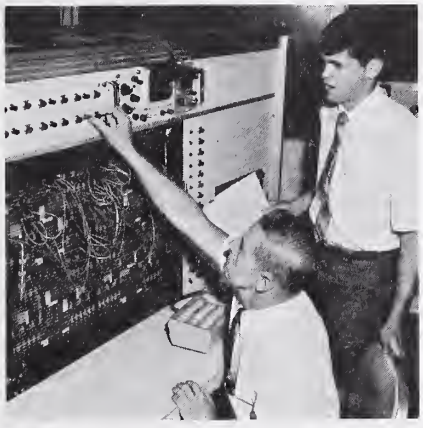
Method for Selecting Contract Cost Incentives, A, Ralph E. Miller (Rand), Q 180 .A1 R18 no. 5122.

Observing Earth Satellites, Desmond King-Hele, TL 796 .K541.

International Science Fair Winners Visit Army Labs



USING A COMPUTER to test his International Science Fair entry, Scott Jenkins watches as Joseph E. Wilson of Rock Island (Ill.) Arsenal's Laboratory Computer Section makes necessary adjustments. An exhibit titled "Development of a Neutron Boundary Layer Disturbance Theory for Drag Reduction by Acoustical Interaction" won Jenkins a week's visit to the Army laboratory of his choice. The 16-year-old Valley High School student of Albuquerque, N. Mex., also was selected as the Army representative to participate as a good will envoy to the 11th annual Japan Student Science Awards to be presented in Tokyo in January, 1968.



SEASHELLS TO SATELLITES was the move made by Kathleen R. Page when she was the guest of the Army during a recent week's visit to the U.S. Army Engineer Topographic Labs at Fort Belvoir, Va. The 18-year-old student of Tulsa (Okla.) Central H.S. was an Army award winner for her project, "Factors Influencing the Orientation of Shells on a Beach," exhibited at the 18th International Science Fair. Shown here with C. Edward Westerman, chief of Surveying Systems, she is viewing the SECOR (Sequential Collation of Range) satellite used in gathering information on the exact location of land bodies.

ARMY ISF WINNER David Hutchens talks with Maj Gen Philip W. Mallory, CG of Walter Reed Army Medical Center (WRAMC), and Col Leslie B. Alstatt, special assistant to the director of Walter Reed Army Institute of Research, during one-week visit to the center in Washington, D.C. Hutchens also was selected as alternate U.S. representative to the 1968 Japanese Student Science Awards for his exhibit "Correlative Effect of Indoklon and EST" at the International Science Fair. The 17-year-old science student is a 1967 graduate of Terry Parker H.S., Jacksonville, Fla., and is studying under a fellowship at the University of Florida.

SCIENTIFIC CALENDAR

Northeast Research and Engineering Meeting, sponsored by IEEE, Boston, Mass., Nov. 1-3.

Asilomar Conference on Circuits and Systems, sponsored by IEEE, Pacific Grove, Calif., Nov. 1-3.

13th Conference on the Design of Experiments in Army Research, Development and Testing, sponsored by ARO-D and USAETL, Fort Belvoir, Va., Nov. 1-3.

International Conference on Plasma Confined in Open-Ended Geometry, sponsored by the Oak Ridge National Labroatory, Gatlinburg, Tenn., Nov. 1-3.

Operations Research Society of America Meeting, Chicago, Ill., Nov. 1-3.

Reliability Physics Symposium, sponsored by IEEE, Los Angeles, Calif., Nov. 5-8.

Atomic Industrial Forum, Chicago, Ill., Nov. 5-9.

Winter Meeting of the American Nuclear Society, Chicago, Ill., Nov. 5-9.

1967 Conference on Speech Communications and Processing, sponsored by AFCRL and IEEE, Cambridge, Mass., Nov. 6-8.

Applied Superconductivity Conference, sponsored by ARO, NASA, ONR, AFOSR and University of Texas, Austin, Tex., Nov. 6-8.

Panel on Microbiological Standards and Testing Methods for Irradiated Foods, sponsored by FAO and IAEA, Vienna, Austria, Nov. 6-10.

Symposium on Automatic Support Systems for Advanced Maintainability, sponsored by IEEE, Clayton, Mo., Nov. 7-9.

4th Session of the World Meteorological Organization, Montreal, Canada, Nov. 12-Dec. 13.

7th Conference on Thermal Conductivity, sponsored by NBS, Gaithersburg, Md., Nov. 13-15.

Conference on Engineering in Medicine and Biology, sponsored by IEEE, Boston, Mass., Nov. 13-16.

Fall Joint Computer Conference, sponsored by IEEE, Anaheim, Calif., Nov. 14-16.

American Society of Tool and Manufacturing, Engineers—Regional Exposition, Boston, Mass., Nov. 14-16.

Meeting of the American Mathematical Society, Knoxville, Tenn., Nov. 17-18.

Meeting of the Geological Society of America, New Orleans, La., Nov. 20-22.

Meeting of the American Institute of Chemical Engineers, N.Y.C., Nov. 26-30.

Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 26-Dec. 1.

16th Annual Wire and Cable Symposium, sponsored by AMC, Atlantic City, N.J., Nov. 29-Dec. 1.

32 H.S. Students Participate In WRAIR Summer Program

Thirty-two high school students selected for outstanding ability and interest in the biological sciences participated in a summer study and work program at the Walter Reed Army Institute of Research (WRAIR), Washington, D.C.

The students represented three programs in which WRAIR participates. Twenty-four were part of the Research Participation Program for Senior High School Students, sponsored by the Joint Board of Science Education and the American University.

Five represented the High School Heart Research Program, sponsored by the Washington Heart Association, Inc., and three were sponsored by the American Cancer Association of Washington.

Each of the participants worked under the supervision of a specialist in the student's field of interest. This policy has been followed since the WRAIR summer work-study program began eight years ago, and it enables students to gain the career guidance they desire.

The students were selected on the basis of high grades in mathematics and science upon recommendation of their teachers.

Kudos

DISTINGUISHED SERVICE MEDAL (DSM). Brig Gen John G. Schermerhorn received the DSM upon his retirement after more than 30 years of Army service. He last served with the U.S. Army Materiel Command as Director of Major Items, a position now filled by Brig Gen Howard F. Schiltz.

MERITORIOUS CIVILIAN SERVICE AWARD. Roy D. Green, chief of the Research Programs Branch, Research Programs Office, Office of the Chief of Research and Development (OCRD), received the Decoration for Meritorius Civilian Service for the period February 1963 to July 1966.

The citation stated, "Mr. Green's broad comprehension of Army organization and procedures, as well has his sound interpretive and analytical approach to problem solving in the field of research programing and budget execution, have earned him the universal respect of scientists and counterparts in the research community.

"He has played a key role in formulation of basic fiscal policies and research programs for the Army Research Directorate during this period."

CHIEF OF R&D Lt Gen Austin W. Betts presents MCS Award to Roy D. Greene.

CHOUNG MY MEDAL. Maj Olga Ricknell, Army Nurse Corps, was awarded the Vietnamese Choung My Medal for meritorious service with the 8th Field Hospital. She is now assigned to DeWitt Army Hospital, Fort Belvoir, Va.

LEGION OF MERIT (LOM). Col Aley L. Smith, deputy assistant director, Office of Plans and Policy, Defense Communications System, Defense Communications Agency, received the LOM for his service in insuring effectiveness of communications and electronics for command and control of U.S. forces in Southeast Asia.

KEY COMMUNICATIONS contributor Col Aley L. Smith is congratulated on receipt of Legion of Merit by Maj Gen Richard Klocko, USAF, deputy director, Defense Communications Agency.

The citation recognized his service as deputy assistant chief of staff, Communications and Electronics, HQ U.S. Army Pacific Command, where he "was a key contributor in the definition of design of the Integrated Wideband Communication System in the Republic of Vietnam and in Thailand. In addition, he authored many of the basic concepts for employment of communication satellites which are used in the Initial Defense Communications Satellite Project."

Col Ben Wechsler received the LOM before leaving the U.S. Army Combat Developments Institute of Land Combat, Fort Belvior, Va., for a new assignment in Korea. He was cited for his outstanding service as director of personnel and then as commanding officer of the institute.

Col James S. Dunn was awarded the LOM upon his retirement from 25 years service. The citation noted his contributions as director of the General Equipment Test Activity's Service Test Directorate, Fort Lee, Va. He also received the Quartermaster Medallion.

Col Dunn was assigned to the Office of the Chief of Research and Development (OCRD), 1959-62, serving as deputy chief, European Research Office, staff officer Geophysical Science Branch, and chief, Research Actions Division.

Col John F. Polk, special assistant to the deputy CG, and Col Robert P. Johnson, Staff Judge Advocate, U.S. Army Test and Evaluation Command, were awarded the LOM upon their retirement.

Col T. A. Rodgers received the LOM prior to his retirement from active service at the U.S. Army Missile Command (MICOM), Redstone Arsenal, Ala. He was cited for outstanding contributions while serving as head of the Missile Intelligence Directorate.

Prior to assignment to Redstone, he was with the R&D Division (J-5), Office of the Joint Chiefs of Staff. He was assigned to OCRD from 1958 to 1961 as chief of the Missiles and Space Division.

Lt Col Pierre A. Finck, chief, Military Environmental Pathology Division of the Armed Forces Institute of Pathology, was awarded the second Oak Leaf Cluster to the Legion of Merit. He was cited for his part in establishing the first pathology center for the Armed Forces in Vietnam as commander of the 9th Medical Laboratory.

For service with the Army Materiel Command, Lt Col Robert W. Noce received the LOM "for being instrumental in developing and managing a joint program of testing for the Main Battle Tank-70 and for the Heavy Equipment Transporter-70 that successfully met the criteria established by this country and the Federal Republic of Germany."

Then chairman of the Joint Test Coordination Working Group, Col Noce is now a student at the Industrial College of the Armed Forces.

Lt Col James F. Thornley received the LOM for successive service as chief, Logistics Division, deputy commander and commander, HQ U.S. Army Strategic Communications Command for the Continental U.S., August 1964 to June 1967.

Lt Col Clair L. Rishell received the LOM and a Certificate of Appreciation upon his retirement. He served in OCRD since 1965 as chief, Standardization Branch, International Office.

The citation noted that "his most exemplary service was performed during a 2-year series of meetings that climaxed in

LEGION OF MERIT is presented to Lt Col Clair L. Rishell by Brig Gen Kenneth F. Dawalt, Deputy Chief of R&D for International Programs, OCRD.

the American-Canadian-Australian Project Mallard Agreement.

"In addition, Lt Col Rishell was the catalyst behind the United States/United Kingdom Cooperative Research agreement on lasers and the trilateral (United States/United Kingdom/Federal Republic of Germany) 155mm howitzer international ballistics standardization agreement."

BRONZE STAR MEDAL. Maj William R. Gardner, a surgery resident at Walter Reed General Hospital (WRGH), was honored with the BSM for

service in 1966 as brigade surgeon, 3rd Brigade Task Force, 25th Infantry Division, Vietnam.

Maj Charles Ross, director of facilities at Edgewood Arsenal, Md., received the BSM for service in Vietnam with the 937th Engineer Group.

Maj Robert A. Vitori, a student at the U.S. Army Institute of Dental Research, was awarded the BSM for service as a dental officer in Vietnam, where he was also active in the Medical Civil Action Program in various hamlets.

Capt Charles Cook, aide-de-camp to the commanding general, U.S. Army Aviation Materiel Command, earned the BSM as well as first and second Oak Leaf Clusters (OLC) to the Air Medal for service in Vietnam. He was cited particularly for devotion to duty while on more than 25 aerial missions over enemy territory, July 1966 to May 1967.

Capt Howard E. Kalis III, adjutant at the Walter Reed Army Institute of Nursing (WRAIN), received the BSM with 1st OLC for meritorious service in ground operations against hostile forces while assigned to the 275th Medical Detachment, 1st Infantry Division in Vietnam.

ARMY COMMENDATION MEDAL (ACM). Lt Col Adam E. Adams, Medical Service Corps, recently assigned to the Armed Forces Radiobiology Research Institute (AFRRI) as chairman, Military Analysis Department, received the ACM for service in his previous assignment. He was chief, Nuclear Science Branch and deputy director of the Nuclear, Biological and Chemical Sciences Department, Army Medical Field Service School, Brooke Army Medical Center, Fort Sam Houston, Tex.

Lt Col George H. Crampton, Edgewood Arsenal Research Laboratories, received the ACM for his service as research psychologist and chief of the vestibular branch of the Army Medical Research Laboratory's division of experimental psychology, Fort Knox, Ky.

Lt Col Robert L. Bryant received the ACM upon his retirement. He was commended for his "exceptionally meritorious service" with the Nike-X and Space Division, OCRD, July 1966 to August 1967.

Maj Anna E. Everett, an operating room nurse at WRAIN, was awarded the ACM for "excellence as an instructor in medical surgery nursing and as a clinical adviser" at the institute, February 1965 to May 1967.

Maj Harold L. Rudman, assistant chief, Anesthesia Service at WRGH, was awarded the ACM for service as chief, Anesthesia Service, Gorgas Hospital, Canal Zone.

Maj Mary V. Russell, an instructor in pediatric nursing at WRAIN, received the ACM for display of "exceptional qualities as a teacher, adviser, and practitioner" September 1965 to May 1967.

Two students at the U.S. Army Institute of Dental Research, Maj James Auzins and Maj Thomas R. Tempel, earned their ACMs in Vietnam and Mannheim, Germany, respectively.

Capt David Alabran received the ACM for services as a chemical research engineer with Rock Island (Ill.) Arsenal. Capt John L. Hicks, a dentist at Edgewood Arsenal Dental Clinic, received the ACM for service in Vietnam.

The first OLC to the ACM was presented to Sgt Maj Luther T. Hendrix of the Nuclear Power Field Office (NPFO), Fort Belvoir, Va., for service as plant supervisor while assigned to the first crew of the *Sturgis,* the U.S. Army's first nuclear floating power plant.

MSgt Robert T. Shakour, also of the NPFO, received the ACM for meritorious service as instrument technician and supervisor of shift work, operations and maintenance at the SM-1 power plant.

Cleveland O. Glenn, NPFO, received the Department of Defense Antarctica Service Medal for his service as a member of one of the Navy teams participating in "Deep Freeze 67." A draftsman in the Engineering Department of the NPFO, his assignment in the Antarctic was concerned primarily with updating and revising drawings for the Navy's PM-3a nuclear power plant.

Volume Lists Federal Information Resources

A Directory of Information Resources in the United States: Federal Government, newly published by the Library of Congress, was prepared by its National Referral Center for Science and Technology.

The 419-page book may be purchased at $2.75 a copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

All appropriate Federal Government information resources, as well as information resources sponsored in whole or in part by the U.S. Government, are represented in the new publication. More than 1,600 resources are included.

The directory describes the areas of interest, the holdings, the publications, and the information services of the various agencies, offices, libraries, committees, commissions, boards and other organizations listed.

Material for the publication came from the National Referral Center's central register of information resources that has been built up since the center was established in 1962 with the support of the National Science Foundation. Each entry in the directory was submitted to the organization it describes to insure textual accuracy.

This is the fourth directory published by the National Referral Center. Others are (1) *A Directory of Information Resources in the United States: Physical Sciences, Biological Sciences, Engineering;* (2) *A Directory of Information Resources in the United States: Social Sciences;* and (3) *A Directory of Information Resources in the United States: Water.*

In addition to publishing directories of information resources, the center has a free referral service to direct those who need information to those who can provide it. In response to telephone or mail requests for assistance, the center provides names, addresses, telephone numbers, and brief descriptions of information resources.

Details about the center's activities can be obtained by telephoning 967-8242 (area code 202) or by writing to the National Referral Center for Science and Technology, Library of Congress, Washington, D.C. 20540.

Keegan Heads Defense Research Office in Latin America

Col Hugh L. Keegan, known internationally as an authority on insect venoms, has been named chief of the Defense Research Office for Latin America (DROLA) in Rio de Janeiro, and commander of the U.S. Army element.

DROLA is a group of Army and Air Force personnel who represent their services in seeking out South American scientific research worthy of grant and contract support. The Army has U.S. Department of Defense executive responsibility for the organization.

Col Hugh L. Keegan

Col Keegan's last assignment was at Brooke Army Hospital, San Antonio, Tex., where he instructed resident physicians. From 1962-66 he was chief of the Department of Entomology at the 406th Medical Laboratory in Japan.

He was an instructor of medical entomology in the Department of Preventive Medicine, Army Medical Field Service School, 1951-52 and 1957-62.

Assigned to Walter Reed Army Institute of Research from 1952 to 1954, he then served three years with the Far East Medical Research Unit, Office of The Surgeon General. He has written several texts on insects, particularly those of the Far East.

Col Keegan holds MS and PhD degrees from the State University of Iowa in the fields of zoology, medical entomology and parasitology. He received a BEd degree from North Illinois State Teachers College in 1938.

Army Role in Fuel Cell R&D Spurs Worldwide Interest

By Dr. Sidney J. Magram

Widespread growth of interest in fuel cell research and development was demonstrated in June 1967 at the Second International Meeting on Fuel Cells in Brussels, Belgium. Scientists from 16 nations presented 66 technical papers on R&D directed toward utilizing potential advantages of fuel cells as the electrical power source for special requirements.

The "Sixth Status Report on Fuel Cells" was prepared and distributed in May 1967 by the U.S. Army Electronics Command as host to the 21st Annual Power Sources Conference in Atlantic City, N.J. — each year one of the world's largest gathering of experts interested in developing unconventional power sources as well as improving the efficiency of other power plants.

Pioneering interest in fuel cell research for application to precise military requirements was reflected in the first status report published in June 1959 by the U.S. Army Research Office, Office of the Chief of Research and Development. A second report was issued in 1960.

Sale of the first report through the Office of Technical Services (since redesignated the Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce), set a record for technical documents. Collectively, the Army status reports on fuel cells have had a vast impact in stimulating worldwide interest.

International interest when the first report came out was limited primarily to work in England on the hydrogen-oxygen fuel cell and in the Netherlands on a high-temperature molten salt system, with fragmentary information on some research in Germany and in the Soviet Union.

Significant among the hardware developmental programs has been the carefully calculated and profitable gamble of the National Aeronautics and Space Administration on the hydrogen oxygen fuel cell for the United States space program. An ion-exchange membrane type of fuel cell was developed to provide electrical power for the extended Gemini missions, followed by developments for the Apollo and post-Apollo power systems.

Much of the NASA research on the hydrogen-oxygen system provided information useful for Army requirements. Use of hydrogen as a compressed gas or a cryogenic fluid, however, was not considered logistically feasible for Army purposes and other systems using condensed fuels had to be evaluated in Army research.

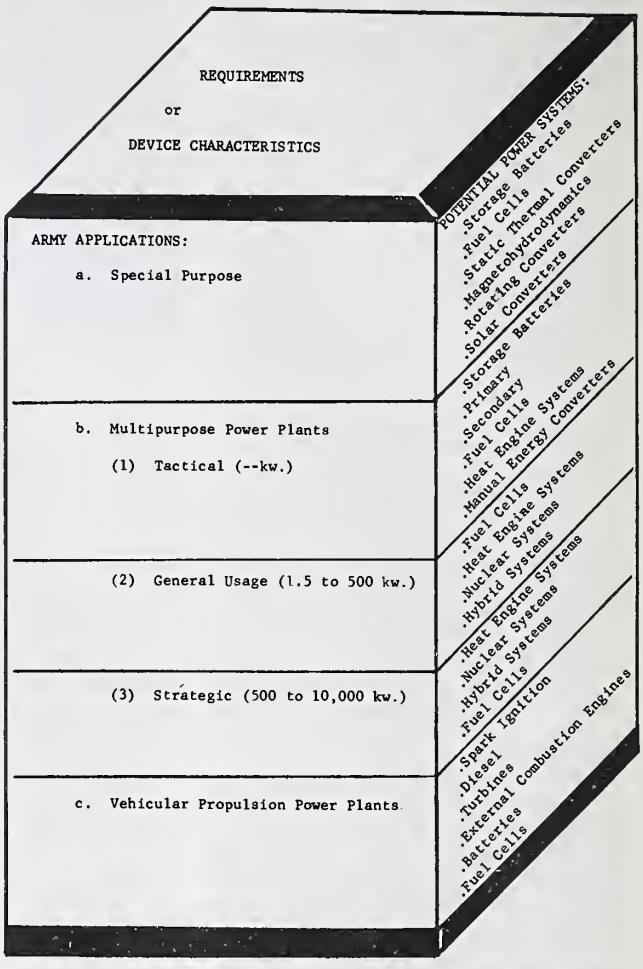


Figure 1. Applications, Requirements and Potential Devices in Army Electric Power Programs.

In the Department of Defense, the fuel cell program from 1960 to 1965 was supported heavily by the Army and, to a still larger extent, by the Advanced Research Projects Agency (ARPA) under Project Lorraine. ARPA discontinued support by the end of FY 1965 because much of the program was considered ready to enter an engineering study or preliminary prototype development state.

Extensive support from 1960 to 1965 was given to a series of investigations to determine feasibility of directly oxidizing hydrocarbon molecules in a fuel cell. Largely out of such work came the invention of thin waterproofed electrodes which permitted easy diffusion of complex fuels to the activated sites on electrodes, with subsequent desorption of reaction products. Special catalysts on substrates were developed which were effective in oxidizing a wide range of fuels at the fuel cell anode.

A significant advance was the use of teflon-bonded electrodes for control of wetting properties, so that moisture control could be maintained with free or matrix-type electrolytes even with ambient air as an oxidizer.

A wealth of literature on fuel cells has been published since 1959. Still it would be misleading to present a review on the potential advantages and progress in fuel cells without taking into account the many factors that determine whether a device will eventually become a useful piece of hardware for the Army. The balance of this review will discuss three aspects of the fuel cell program:

- How fuel cell power fits into the overall Army Electrical Power Program.
- A list of the prototype fuel cells being investigated and a discussion of the most highly developed systems.
- An identification of the problem areas where further work is necessary.

Electrical Power Program. Let us first review the following three aspects of the Army Electrical Power Program. One could prepare a system of matrices, as shown in chart form in Figure 1, in which each potential power device is rated for each requirement, which is turn depends upon the kind of application.

Applications may be subdivided roughly into three areas wherein the type determines the priority of the requirements: (a) Special purpose applications including small, silent power plants; (b) multipurpose power plants for tactical, general usage and strategic power; and (c) vehicular propulsion power plants.

The requirements include an identification of the characteristics that a power device will need by the time it is adopted as an end-item. Fuel cells are being investigated primarily for their potential efficiency and reliability, silent operation and reduced exhaust signature.

Any power device, however, will have to be evaluated according to a more complete list of requirements: weight and volume of device, power density such as watts of maximum power per weight of equipment, energy density such as kilowatt hour per poundof equipment, efficiency of fuel utilization, silence of operation, and variation of efficiency of operation with

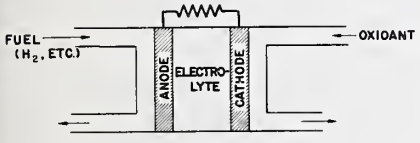
temperature changes. Additional factors are time for start-up of operation, lifetime of operation between maintenance overhauls, reliability, cost and availability of fuel and other materials, and operation with special fuel or multiple fuel.

A list of the kinds of fuel cells must be compared with all other competitive devices and systems under study. For example, a thermo-electric device with only three percent fuel efficiency may turn out to be more useful than a fuel cell with a much higher efficiency when the overall weight of the thermoelectric device is better and it can use a variety of fuels instead of a special fuel.

Prototype Fuel Cells. In that several types of devices are under each power system, the chart in Figure 1 is oversimplified. Figure 2 is a simple diagram of a fuel cell showing also some potential advantages. In addition to the fuels, it contains electrodes and electrolytes, each of which can be varied to produce a variety of cells. Catalysts which enable faster reaction at electrodes to take place frequently are a critical item.

While the oxidant may be oxygen, air or chlorine, the reductant may be hydrogen, ammonia, active metal or one of many organic compounds. The electrolyte may be an acid or alkali aqueous solution, a high-temperature molten salt, or a solid electrolyte.

Figure 2. Fuel Cell Battery



ADVANTAGES

1. SILENT OPERATION
2. HIGH EFFICIENCY
3. LOW OPERATING TEMPERATURES
4. SIMPLE, RELIABLE OPERATION
5. LOW MAINTENANCE
6. OPERATION WITH VARIETY OF FUELS

Systems now of interest (besides the molten salt system) are essentially hydrogen-oxygen fuel cells where the oxidant is air and the fuel is a hydrogen-supplying material such as metal hybride, hydrazine, ammonia, methanol, pure hydrocarbons, CITE (compressed ignition turbine engine) fuel and combat gasoline.

Fuel cell systems, however, are much more complicated than the cell itself. Since each cell yields something on the order of one volt, it is necessary to connect cells in series and/or parallel to produce practical devices. Construction of such a battery system will involve problems in heat transfer, construction, design and maintenance.

Fuel cell systems developed to the operational hardware stage will require electrical circuits and techniques for starting, sequencing, fuel feed control, and voltage regulation. Such equipment increases the cost and complexity of the entire fuel cell system.

Prototype fuel cells investigated by the Army have had these complicating engineering problems to take into account in their development. The fuel cell systems under contract are listed in Figure 3, showing the power output, fuel used, contractor, date started, and the number of units to be procured.

The principal current fuels are hydrazine, methyl alcohol and hydrocarbons, and the oxidizer is air. One of the program goals is to develop a cell using CITE fuel.

The 60-watt, 100-watt and 500-watt fuel cells are being investigated by the U.S. Army Electronics Command, Fort Monmouth, N.J., and the balance by the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, Va.

Power Output	*Fuel*	*Contractor*	*Date*	*Units*
60 W	N_2H_4	Monsanto	6/65	12
100 W	MeOH	Esso	10/65	1
500 W	HC	Pratt & Whitney	11/64	3
300 W	N_2H_4	Union Carbide Monsanto	9/65	119
1.5 KW	HC	General Electric	5/66	5
5 KW	N H_4	Monsanto	6/65	8
15 KW	CITE	Texas Institute	7/66	1
40 KW	N_2H_4	ERDL	1/65	1

Figure 3. Prototype Fuel Cells

The Electronics Command has been primarily concerned with the power sources below one kilowatt, designed primarily to power radars, radios and communication equipment. The U.S. Army Mobility R&D Center has been concerned with the larger power sources required for general purpose and vehicular power. Many of the research problems in both laboratories are intimately related but the actual systems under investigation are different.

Special-purpose applications cover requirements that cannot be met with the multipurpose power plants. An example is the use of fuel cell-battery hybrids to assist batteries as power sources for communication and surveillance equipment where silence of operation is also a necessary requirement.

An attractive application for fuel cells is to use them in combination with a secondary battery. The battery provides the high power pulses for transient loads and the fuel cell efficiently and continuously converts chemical energy into electrical energy to supply the lower power demands and keep the battery charged.

A fuel cell of approximately 30 to 60 watts continuous output can be combined with batteries with 0.5 to 4-ampere-hour storage capacity to satisfy a wide range of equipment duty cycles. The total amount of fuel required to supply 30 to 60 watts for eight hours is a fraction of a pound. Because large quantities of fuel are not involved, any fuel can be considered which can be safely stored and handled and is sufficiently reactive.

A liquid form of fuel, hydrazine N_2H_4, has been shown to be very reactive and almost an ideal fuel for 30- to 60-watt fuel cells. Solid fuel, alkali and alkaline earth hydrides are also attractive as a compact form of fuel. Methanol and liquid hydrocarbons for the 60-watt level have not been found practical at their present stage of development because the required systems would be too heavy, complicated and expensive.

A 30-watt fuel cell based on solid hydrogen, in the form of a tablet of lithium hydride, is being investigated as one of the simplest approaches to a battery-fuel cell hybrid configuration. The 30-watt unit is based on components developed by General Electric Co. at its own expense.

The unit has a Kipp-type hydrogen generator, which reacts with water to liberate hydrogen, and a fuel cell of the ion-exchange membrane type with an air-breathing cathode. The basic package consists of two 14-volt, 15-watt fuel cell modules to provide 14 or 28 volts to the user equipment. The hydrogen generator and fuel tablet are designed to produce hydrogen for 240 watt-hours output per charge. Detailed tests are expected to prove this system will have low maintenance and high reliability.

A 60-watt hydrazine-air fuel cell has been developed over the last two years by the Monsanto Research Corp. Being packaged in the hybrid configuration with 38 cells for use with storage batteries, it is expected to meet a wide range of Army applications.

Fuel concentration during operation is kept at approximately 1 to 1.5 mole N_2H_4 in 5-molar KOH by an electrochemical pump, a gas coulometer operated by a current-proportioning unit. The fuel tank, containing hydrazine hydrate with 0.1 percent KOH, is closed and the gas from the coulometer forces fuel into the electrolyte tank at the proper rate.

Air furnished is four times the stoichiometric amount needed for full power, 60-watt operation and is constant. The fuel cell is equipped with a solid-state voltage regulator to provide 28, 14 or 7 volts at 60 watts output.

Models have been fabricated and delivered to the Electronics Command. The performance of the exploratory model and the required performance of the advanced model are compared in the table on page 36.

Major problems encountered included development of the auxiliary components such as blower motors, pumps, fuel feed-control system and voltage regulators. As fuel cells with longer life performance

(Continued on page 36)

Army Role in Fuel Cell Research and Development

(Continued from page 35)

were obtained, additional problems were encountered — excess noise level of cooling blower, ammonia evolution from exhaust, excess electrolyte changes needed due to carbonation of the KOH electrolyte by CO_2 from the air, and peripheral electrolyte leakage from the

60-Watt Hydrazine Fuel Cell Performance

	Advanced Model Requirement	*Exploratory Model Performance*
Weight + fuel + electricity	10 lbs.	14.5 lbs.
Volume	0.75 cu. ft.	0.35 cu. ft.
Power output	60 watts	60 watts
Operating life	750 hrs.	450 hrs.
Voltage Regulation 28V., 14V. and 7V.	±5%	±10%
Watt-hours/ Fuel charge	720	390
Fuel charge + container	2 lbs.	1.15 lbs. container
Low temperature	−40°F.	+14°F.
High	+125°F.	+115°F.

cells. Steps are underway to eliminate these defects in order to obtain the characteristics set up for the advanced model.

The 60-watt fuel cell system has shown its capability to supply ample power for Army portable radar sets PPS/4 and PPS/5. A breadboard model of a hybrid fuel cell system was made and demonstrated. This fuel cell is a combination of a 60-watt system and a nickel-cadmium secondary battery. The integrated compact package, weighing less than 20 pounds, is designed to eliminate the need for heavier, noisy engine-generator equipment required for recharging batteries.

A self-contained methanol fuel cell battery demonstrator was developed by Esso Research and Engineering Co. and delivered to the U.S. Army Electronics Command. The model is not a prototype, as are some of the other devices listed in Figure 3. The system is described in the "Sixth Status Report on Fuel Cells."

Methanol has attractive properties for a fuel cell in that it is water soluble, can be dissolved in acid or alkaline electrolytes for delivery to fuel electrodes, is relatively inexpensive and readily available. Menthanol cells can operate below 80° C.

An experimental methanol model weighs 94 pounds, including integral controls to handle cooling, fuel feed and voltage regulation. The output power is 130 watts and the expected lifetime is 600 hours. Additional work remains to increase the energy density to more practical levels. The present weight of the system is excessive for military application as a portable fuel cell.

A methanol-air fuel cell might be considered for stationary applications where continuous unattended operation over extended periods is possible and where the weight of the system, water and fuel are not factors. It cannot be considered competitive with the present 30-watt lithium hydride or the 60-watt hydrazine fuel cell.

In the multipurpose power plants there is an overlap of the power requirements. The special-purpose fuel cells for tactical applications being investigated to supply silent electrical power are the 0.3 kw., the 0.5 kw. hydrazine fuel cell and the 1.5 kw. hydrocarbon fuel cell. General usage fuel cells up to 5 kw. and those above 10 kw. show an increasing demand on economy, low upkeep and long life.

The standard family of engine generators developed by the U.S. Army Mobility Equipment Command is designed to generate the bulk of the kilowatt hours of electrical power needed by the field Army. Army requirements for electrical power in the 1- to 100-kw. range are currently provided with skid- or trailer-mounted engine-generator sets. In the 1- to 10-kw. power range, diesel-powered sets using commercial engines predominate. Gas turbine engines are used where lightweight equipment is essential. The Army has 20,000 generator sets in Southeast Asia in the 1- to 100-kw. range.

No satisfactory device is currently available to the field for fulfilling requirements for silent engine generators above the one-kw. power level. Because of their present high cost, fuel cell systems probably will not quickly replace the gasoline spark ignition engine, the diesel engine, or the turbine engine generator. Other systems to provide less noisy generator systems are in various stages of development. Competitive devices to the fuel cell for such uses are the Sterling cycle, the mercury-Rankine and water-Rankine systems.

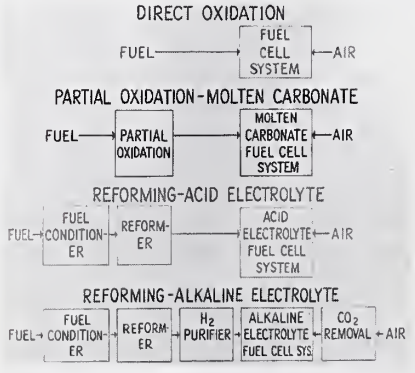


Figure 4

HYDROCARBON FUEL CELL POWER PLANTS

Hydrocarbon fuels apparently must be used as the only logistically available fuel within the next decade, at least. Figure 4 is a diagrammatic scheme of the various approaches to possible hydrocarbon fuel cell systems. The least complex involve the direct oxidation of hydrocarbons. Improvement in power density from 1-2 watts/square feet in 1962 to 5-20 watts/square feet in 1967 provided enough incentive to continue research on hydrocarbon electrode kinetics and catalysis, but present performance is too low and would be too expensive for practical applications.

The next simplest fuel cell system uses a molten carbon electrolyte retained in a porous magnesia filling between anode and cathode screen structures. The 15-kw. system design under study by Texas Instruments Co. is based on a feasibility model which in 1963 demonstrated conversion of a range of hydrocarbon fuels to produce electrical power.

This system, in which a liquid hydrocarbon (CITE fuel or combat gasoline is converted to gaseous fuel in an air partial oxidation, can be used with high sulfur content without the requirement for the removal of sulfur. The molten carbonate electrolyte is attractive because it permits the use of non-noble metal electrodes, nickel on the fuel side and stainless steel with a light silver plating on the air side.

The 15-kw. system design is still in the study stage. Recent work is concentrating on lower weight modules and 50 to 60 square feet of cell area will be incorporated in a one-kw. breadboard model planned for September 1967.

Scale-up of this system to 15-kw. has many unknowns and the main problem is long-term reliability of high-temperature components. Power densities and efficiencies in this range must surpass the capabilities of the new higher-speed diesels. If the total system complexity and cost fabrication can be reduced, the power density in pounds per kw. changed from 150 to 50-75 and the life between major overhauls raised to 1,500 hours, this system has significant potential in this power range.

The last two most complicated fuel cell systems in Figure 4 are the most highly developed and are now under evaluation as prototype fuel cell systems. They may have direct applicability to special-purpose fuels for forward-area battery recharging. The General Electric Co. 1.5-kw. hydrocarbon-air fuel cell system is a reformer-acid electrolyte system and is specifically being developed by the U.S. Army Mobility Equipment Command for Southeast Asia application. The Pratt and Whitney Aircraft 500-watt hydrocarbon fuel cell system has an alkaline electrolyte. A press announcement of this system was made recently by the U.S. Army Electronics Command.

The 1.5-kw. fuel cell weighs 140 pounds, including all accessories and fuel for 1.5 hours of start-up and operation, except water for operation above 110° F. A detailed list of the characteristics is available in the "Sixth Status Report on Fuel Cells." The main characteristics, together with future objectives, may be summarized as follows:

1.5-kw. Power Plant Status

	Today	*Objective*
Power density (lbs./kw.)	100	50–75
Efficiency Percentage	20	35–40
Life (hrs. between major overhaul)	500–1000	1500
Cost $/kw.	4000	500–1,000
Fuel	Desulfurized liquid hydrocarbon	'CITE' Combat gasoline

The 500-watt indirect hydrocarbon fuel cell, believed to be the first in the U.S. to use a standard hydrocarbon fuel, was developed as a portable unit for powering radars, radios and other electronic combat equipment. Reaction of 1.6 pounds of kerosene with 5.6 pounds of water in the reformer produces enough hydrogen to generate peak power for six hours. A detailed list of characteristics is available in the "Sixth Status Report on Fuel Cells." Some main characteristics may be summarized as follows:

500-Watt Hydrocarbon-Air Fuel Cell
Wt: 83 lbs. (42 Hz generator + 41 fuel cell battery)
Fuel + water (4 hrs. operation) 7.2 lbs.
Volume: 2.6 cu. ft.
Net power: 50-500w.
Voltage range: 33-29 v. at 50-550 w.
Start-up time: 33 min. (500 w.)
Low temp: $+35^0$ F.
High temp: 120^0 F.
No. Cells: 36
30 percent KOH (asbestos matrix)
Power plant efficiency (30 percent at full-rated 300-watt output)

A picture of the 500-watt fuel cell system with target specifications is given in Figure 5. For a lighter-weight forward-area battery charger, hydrazine may be superior to the presently available hydrocarbon fuel cells. A 500-600 watt Pratt and Whitney system which weighs 95 pounds will be equivalent to a 60-pound hydrazine fuel cell. The hydrocarbon fuel at these power levels has the advantage that is is already in the logistic supply system. The disadvantage of a special hydrazine fuel could be counterbalanced by the importance of the need of a lighter-weight recharger.

A 300-watt hydrazine power plant was developed originally by Union Carbide Co. and is now under further development by Monsanto Co. for use in Southeast Asia. The energy density, 120 watt-hours per pound for 12 hours of operation, is not approached by any other fuel cell, and 119 of these units are to be procured for test and shipment to Vietnam before the end of 1967.

Some features and problems in the 300-watt and 5-kw. hydrazine fuel cell are similar to those of the 60-watt fuel cell previously described. An engineer design model of the 300-watt fuel cell is shown in Figure 6.

Electric propulsion using fuel cells alone or with batteries appears to be the area of application furthest removed from their present capabilities. Because of their high efficiency (30 percent in complete hydrocarbon systems versus less than 10 percent for gasoline engines), fuel cells are being considered for military vehicles. Because they do not emit smoke or harmful gases contributed to air pollution, they also have been receiving nationwide interest as potentially a part of the future electric car.

In recent testimony before the joint meeting of the Senate Commerce Committee and the Public Works Committee of the United States Senate, the Army presented a review on the military interest in power plants for the electric car.

In an Army-sponsored project at the

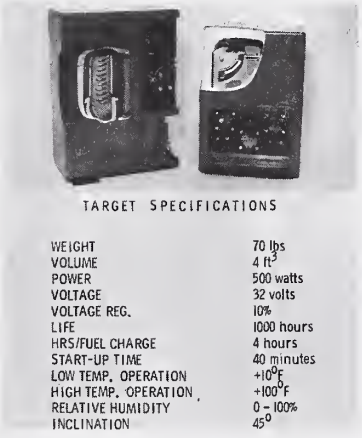


Figure 5
500W Indirect Hydrocarbon Fuel Cell System

Monsant Research Corp., an M-37 vehicle was converted to an electric-drive system by mounting a main propulsion motor on the differential. A hydrazine-air fuel cell using four 5-kilowatt fuel cell batteries was assembled in the engine cavity of the truck. The present 20-kw. fuel cell system used approximately one pound of anhydrous hydrazine per kilowatt-hour of electrical power.

This hydrazine fuel cell truck and a General Motors hydrogen fuel cell-propelled truck are the only known attempts to power full-sized vehicles. A Union Carbide-General Motors project resulted in a fuel cell-powered truck called the Electrovan, which was described at the Society of Automotive Engineers meeting in Detroit in January 1967 and subsequently displayed at the new U.S. Senate Office Building at the Senate hearings in March 1967. This uses a hydrogen-oxygen fuel cell.

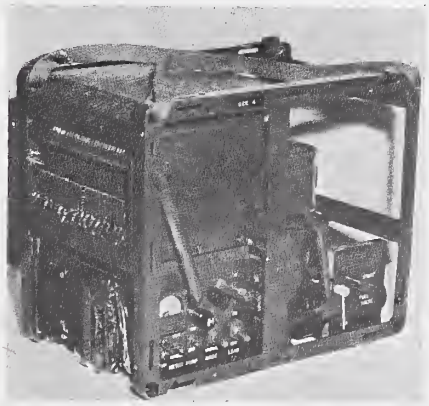


Fig. 6. 300W Fuel Cell

The Electrovan weighs 7,100 pounds, of which 3,930 pounds are required for the fuel cell and the electric drive. The standard van weighs 3,250 pounds and the standard drive train 870 pounds. It is significant that the fuel cell auxiliary system weighed almost as much as the fuel cell modules and the electrolyte. Data from limited operations showed the Electrovan used about one kilowatt of energy per mile and the van could be driven 120 miles on the 12 pounds of liquid hydrogen in a cryogenic tank.

Economics of vehicle propulsion at the present costs of fuels and fuel distribution, shows that hydrogen or hydrazine for any Army Mobility Equipment R&D Center is using the hydrazine fuel cell-powered truck as a research tool to provide data so that the test bed with the proper power conditioning can provide information on how a fuel cell will operate under a variety of load profiles.

Figure 7 shows some pictures of a hydrazine fuel cell-powered truck displayed in conjunction with the presentation to the Senate Committees on Commerce and Public Works entitled, "Department of Defense Research on Unconventional Vehicular Propulsion."

Only one hydrocarbon-air fuel cell currently available has proved its qualities in thousands of hours of successful testing. This is the 500-watt hydrocarbon system designed by Pratt and Whitney Aircraft for the U.S. Army. A similar larger version developed for the gas industry uses natural gas instead of liquid hydrocarbon as the primary fuel. Future development tests of the 1.5-kw. hydrocarbon-acid electrolyte system by General Electric Co. and the planned 15-kw. unit designed by Texas Instruments may add two more potential systems.

Based on an overall rated performance to give an efficiency of 30 percent for a fuel cell system, the present power density extrapolated to kilowatt power levels needed in vehicles is in the range of 50 to 100 pounds per kilowatt of capacity. For the power density required, the best hydrocarbon-air fuel cell is in excess of the total vehicle weight for most vehicle applications.

Although fuel cells can maintain high conversion efficiencies down to 20 percent of rated capacity, the efficiency drops off rapidly with 5 to 10 percent of the peak capacity due to parasitic power demands of the auxiliary equipment. Therefore, the power density of vehicular power plants using hydrocarbon-air fuels would have to be sharply reduced and the system designed to permit the inherent high-energy conversion efficiency to be used.

(Continued on page 38)

Army Role in Fuel Cell Research and Development

(Continued from page 37)

Opinion varies concerning whether future fuel cells will be practical eventually in vehicles as a sole power source or whether they will have to be used in a hybrid system with a high-energy density battery or with a gas turbine. One possible system has been described with a detailed analysis in the "Sixth Status Report on Fuel Cells."

This system proposes a hybrid fuel cell-battery system using a 150-watt-hour per pound molten electrolyte battery and a 20- to 35-pound/kilowatt hydrocarbon fuel cell. The fuel cell-battery system allows one to design a more highly simplified fuel cell to reduce the complexity and weight of conventional hydrocarbon fuel cell systems.

Limitations on development of any such hybrid system for vehicles involve the materials research and evaluation to be done on high-temperature components of the fuel cell and the proposed high-energy lithium-chlorine battery. Various high-energy density batteries are under consideration to reach a goal in excess of 100 watt-hours per pound of battery.

Potential of fuel cells for vehicles warrants continuous consideration. It is not blindly optimistic to expect that high-energy density batteries and fuel cells may be developed to the point that laboratory experimental systems for vehicular propulsion will be investigated within five years.

Problem Areas. In an identification of the problem areas where further research is necessary, the fuel cell program may be divided into the following two classes of investigations:

- Work with hardware of any specific fuel cell system to decrease complexity and cost, and to improve lifetime and reliability are partly development problems in electrical, chemical and mechanical engineering of auxiliary equipment.
- Research problems to permit one to exploit an intrinsically simpler hydrocarbon fuel cell will require significant advances in electrochemical and materials research.

The "Sixth Status Report on Fuel Cells" reviews four problem areas: (a) power conditioning in fuel cells and (b) the need for system simplification fall under the first class of developmental problems. Reviews on (c) electrodes and (d) electrocatalysis and anodic oxidation of hydrocarbons fall under the second class of electrochemical and materials research.

An extensive part of the fuel cell system is the power conditioning required for the complete power package to regulate the performance of the fuel cell and the electric power generated. The fuel cell requires electrical circuits and techniques for starting sequences, fuel feed controls, measurements of fuel concentration in electrolyte, voltage regulation and thermal equilibrium to provide the automatic control of the fuel cell process.

Especially needed is a considerable effort in power conditioning for vehicular propulsion when the flow of electric power is modified and controlled from the output of the power plant to the input to the electric-drive motors. The power-conditioning system on a 3/4-ton test bed vehicle has been developed at the U.S. Army Mobility Equipment R&D Center to evaluate the behavior of fuel cell power plants as propulsion sources.

In the "Sixth Status Report on Fuel Cells," under a discussion of system simplification, the problems involved in the 500-watt hydrocarbon-air fuel cell and a 4-kw. cell developed by Pratt and Whitney are reviewed. The power plants have an alkaline electrolytic cell stack, a high-pressure reformer which generates hydrogen by reaction of hydrocarbons with steam, and a silver-palladium diffuser which produces hydrogen in a very pure state.

The devices are described with flow schematic charts and it is concluded that the best way to obtain reduction in weight of a system in order to increase the power density is to redesign the system to eliminate excess components.

A fuel cell using phosphoric acid electrolyte was considered with the following system simplifications:

- The bulky air scrubbers (see Figure 4 under reforming alkaline electrolyte) required in alkaline systems to remove carbon dioxide from incoming air are not needed and direct use of ambient air is adequate.
- An acid electrolyte stack at 150° C. can operate with an atmospheric pressure reformer using a reformer effluent with a low carbon monoxide content fed directly into the cells. In the Army fuel cell program, it is planned to develop a system to give an overall efficiency above 30 percent, using standard gasoline-type hydrocarbons and having a volume comparable with present engine generators.

A high-rate, low-cost electrode structure for alkaline electrolytes using hydrogen or hydrazine is feasible. The specific catalyst cost based on platinum at performances from 100-175 amperes/square feet at 0.8 voltage has been shown to be under $100 per gross kilowatt.

Electrode material costs (screen supports, carbon carrier, and teflon binder and wet proofing) are less than 1.5 times the catalyst cost since many materials are available and stable in alkaline solutions to give operational lifetimes well over 1,000 hours in fuel cell systems, with only small voltage decreases.

Since pure hydrogen is required, the gas must be purified. The cost for palladium for diffusion in a generator to supply hydrogen to produce one-kilowatt gross power in a fuel cell is estimated to be $700 per kilowatt. This part of the noble metal cost is a major drawback of the alkaline electrolyte system.

OVERALL VIEW OF MODIFIED M-37 VEHICLE EQUIPED WITH FUEL CELL ELECTRIC PROPULSION

VIEW OF ELECTRICAL CONTROLS AND CONVERSION EQUIPMENT IN SEAT WELL. NOTE ABSENCE OF PROTRUSIONS ON FLOOR

VIEW UNDER HOOD SHOWING FUEL CELL ASSEMBLY AND RADIATOR

Figure 7

Fuel Cell-Powered Truck

While acid electrolytes permit a system simplification, they show corrosiveness to most common potential catalysts. The specific catalyst cost of electrolyte structure for acid electrolytes for just the anode may vary from $110 to $20,000 per kilowatt, depending on the fuel.

Another part of the electrode cost with acid electrolyte electrodes is the current collector screen support needed to resist corrosive action of phosphoric and sulfuric acid. Gold-plated tantalum screens ($10/square foot), which are used now, increase electrode costs extensively. Electrode areas needed to produce the above catalyst costs for 1 kw. range from $98-$1,000/kw.

For widespread applications, the electrode structures for impure hydrogen mixtures come closest to meeting the lowest materials costs. For acid electrolyte systems, continued research is necessary on electrode structure, electrocatalysts and materials to improve performance with lower noble metal loadings or new non-noble metal compositions.

In catalysts for fuel cells, the state-of-the-art has changed since 1963 in respect to electrode performance and platinum catalyst utilization. The most promising direct system is the propane cell using platinum black as the anode catalyst and phosphoric acid at about 150° C. as the electrolyte. Platinum black is still of all noble metals the best with respect to performance and corrosion stability in acid electrolytes.

Platinum has a unique position as an electrocatalyst for the anodic oxidation of alcohols and hydrocarbons, involving a threefold approach. Amounts of platinum required for good performance were excessive, prohibiting a reasonable cost level for electrodes. Accordingly, (a) dilution of noble metal, (b) a substitute for noble metals in alloys and (c) a new non-noble metal catalyst were sought.

Only the first approach has had certain success to date.

Catalyst utilization has been expressed in milliamperes per milligram of catalyst (MA/mg). A good platinum-black electrode shows a use of 8 MA/mg at a catalyst loading of 3 mg. Pt/sq. cm. as obtained with propane in 85 percent phosphoric acid at 150° C. when the crystallite size of the black is about 100 angstroms.

Dilution to 10 percent platinum on a carbon-black electrode can increase this to 40 MA/mg with a crystallite size of 26 angstroms. Continued dilution results in a nearly linear decrease in current with a decrease in catalyst. Therefore a compromise is needed in a practical electrode. Higher catalyst utilization up to 200 MA/sq. cm. have been reported with a new cobalt-platinum catalyst on carbon but stability remains to be proven.

The ultimate goal is an inexpensive non-noble catalyst to replace the noble catalysts. A number of alloys, oxides and carbides have been screened, with some promising catalytic effects for hydrogen and methanol, but not for hydrocarbons.

Besides the electrocatalyst and electrode structure, other important variables determining the hydrocarbon anode performance are the fuel molecular structure and the electrolyte of the fuel cells, both of which are discussed in the "Sixth Status Report on Fuel Cells."

SUMMARY. Experimental fuel cell systems — 30-watt with lithium hydride fuel, 60-watt and 300-watt with hydrazine fuel — will be evaluated in the field within the year to fulfill U.S. Army requirements for silent power sources below 500 watts.

While the 500-watt fuel cell using an alkaline electrolyte is the first successful fuel cell to utilize standard hydrocarbons, intrinsically simpler systems using acid electrolytes are needed.

Two new fuel cell systems, the 1.5-kw. hydrocarbon-acid electrolyte fuel cell by General Electric Co. and the 15-kw. molten salt fuel cell by Texas Instrument Co., should provide within the next few years simpler systems of greater power density.

Possibility of developing a fuel cell using a direct reaction of hydrocarbon at the anode at a practical current density is unpredictable. For all systems, an electrocatalyst-electrode program on a long-range basis is certainly required. Knowledge concerning the interaction between electronic and surface structure of catalysts and hydrocarbons in the oxidation mechanism on a variety of catalysts will be needed.

Power conditioning and system simplification through engineering improvements are major efforts, besides the fuel cell itself, in determining whether a fuel cell system will be a practical power package.

ACKNOWLEDGEMENT. No attempt has been made by the author to supply a list of references since previous Army status reports on fuel cells have provided bibliographies. While the material in this review has been obtained from a variety of sources, a good fraction of the information was obtained from briefings prepared for the Office of the Assistant Secretary of the Army (R&D) in 1966 and 1967 and presented by T. G. Kirkland, U.S. Army Mobility Equipment R&D Center and Dr. Galen R. Frysinger and D. Linden, U.S. Army Electronics Command. For a detailed review of many of the Army fuel cell systems and a discussion of their potential and limitations, the "Sixth Status Report On Fuel Cells," prepared by the U.S. Army Electronics Command, is available from the Clearinghouse for Federal Scientific and Technical Information or the Defense Documentation Center.

Dr. Magram is chief of the Energy Conversion Branch, Physical and Engineering Sciences Division, U.S. Army Research Office (USARO). He was chief of the Chemistry and Materials Branch from 1958 to 1963, then spent 30 months as chief of the Chemistry Branch, U.S. Army Research and Development Group, Frankfurt, Germany. Dr. Magram holds a BS degree in chemistry from the University of Pittsburgh and a PhD degree from New York University. He began U.S. Government service in 1940 with the U.S. Army Chemical Corps at Edgewood Arsenal, Md.

2 Engineers Studying at Von Karman Institute

Two U.S. Army aerospace engineers began a 9-month course of intensive postgraduate study last month at the von Karman Institute, a NATO-sponsored training center in Brussels, Belgium.

Each year the institute gives 20 to 30 scientists or engineers from the NATO countries specialized training in experimental and applied aerodynamics. Selected on achievement and potential for career advancement by their agencies, the students must complete and individual research project at the institute in addition to at least 240 hours of selected courses.

DON RUBIN was nominated by the U.S. Army Missile Command. Employed in the Aerodynamics Branch of the Advanced Systems Laboratory, Redstone Arsenal, Ala., he holds bachelor's and master's degrees in aeronautical engineering from the University of Alabama.

Since joining the arsenal in 1960, Rubin has had several technical reports published, including "Tabulated Stability Data for a Series of Ring-Tail Body Configurations at Mach Numbers from 0.8 to 4.4" and "An Experimental Study of the Force Characteristics of a Series of Cruciform Thrust Deflectors Used as Control Devices."

LEROY T. BURROWS was nominated for his achievements in basic and applied research projects in aircraft propulsion and related systems at the U.S. Army Aviation Materiel Laboratories (AVLABS), Fort Eustis, Va.

Burrows received a BS degree in mechanical engineering from Virginia Polytechnic Institute in 1960, and has been employed since then in the AVLABS Propulsion Division.

Col Bach Continuing Water Structure Research

Col Sven A. Bach, medical officer since 1965 in the Scientific Analysis Branch, Life Sciences Division, Office of the Chief of Research and Development (OCRD), was assigned this month to the Institute of Marine Science, University of Miami, Fla.

Administratively, Col Bach is attached to the Walter Reed Army Institute of Research (WRAIR), Washington, D.C. In Miami, he will continue the complex research of water structure, a program of prime interest to scientists for many years. Some of his investigations to date raise questions regarding commonly accepted beliefs.

Before joining OCRD, Col Bach served six years at the U.S. Army Medical Research Laboratory, Fort Knox, Ky., as chief of the Microwave Branch, chief of the Division of Medicine and CO of the laboratory. He was a surgeon with the Armed Forces Special Weapons Project, now the Defense Atomic Support Agency (DASA), from 1956 to 1959.

He received his BS and medical degrees from the University of Nebraska in 1943, interned at Montreal General Hospital, Canada, and served in France and Germany during World War II.

Dr. Bach is author or coauthor of a number of publications, including "Biological Sensitivity to Radio Frequency and Microwave Energy," "The Effects of Lysergic Acid After Cerebral Ablation," "Effects of Radio Frequency Energy on Primate Cerebral Activity," and "Effects of RF Energy on Human Gamma Globulin."

Col Sven A. Bach

Demonstrated Destruction of Nuclear Weapons

By Lt Col Louis G. Klinker

CLOUD GAP Project No. 34 (CG-34) is a field exercise being conducted under the joint auspices of the U.S. Arms Control and Disarmament Agency and the Department of Defense to establish, test and evaluate inspection procedures to monitor the demonstration of nuclear weapons disassembly and destruction.

The purpose of CG-34 is to obtain and assess practical information to support international negotiations on the U.S. proposal to destroy a quantity of nuclear weapons to obtain fissionable materials for transfer to peaceful purposes. Some historical background on this proposal will be helpful in understanding the implications of CG-34.

An offer to transfer normal uranium and fissionable materials to peaceful purposes was originally made in President Eisenhower's "Atoms for Peace" United Nations speech in 1953. This idea was subsequently advanced in various international forums.

In 1960, the U.S. proposed in the United Nations Disarmament Commission that limited quantities of weapons-grade U-235 be transferred to peaceful uses, under appropriate international supervision, if the Soviets would do likewise.

The U.S. representative to the Eighteen Nation Disarmament Committee in Geneva, in April 1963, informally discussed the transfer of fissionable material to peaceful uses with the Soviet delegate. The Soviet reaction was negative.

Four months later, the U.S. representative formally presented a U.S. offer to transfer 60,000 kilograms of fissionable material to peaceful uses if the USSR would agree to transfer 40,000 kilograms. This ratio was suggested to reflect implied relative nuclear capabilities.

The Soviet Union rejected the formal offer on the grounds that no nuclear weapons would be destroyed and existing stockpiles would not be reduced.

U.S. Ambassador Arthur Goldberg countered this argument in his opening speech before the United Nations General Assembly Sept. 23, 1965, by proposing that the transferred materials be obtained by destroying nuclear weapons. This would require the destruction of several thousand weapons.

Designed to field test techniques to demonstrate destruction of nuclear weapons, CG-34 is one of a series of subprojects within the purview of the master Project CLOUD GAP. This project is covered by provisions of Department of Defense Directive 5030.26: Development of Disarmament Inspection Techniques.

Project CLOUD GAP came into being in late 1962 and was formally established as a cooperative venture between the Arms Control and Disarmament Agency (ACDA) and the Department of Defense (DoD) in May 1965 by an interagency memorandum of agreement.

The genesis of the ACDA-DoD Working Agreement on CLOUD GAP, revised in July 1967, is contained in the provisions of Public Law 87-297, ACDA's organic act. It authorizes the ACDA director to use available government and private facilities to further acquisition of a fund of theoretical and practical knowledge concerning disarmament.

The field-test program currently in progress is intended to provide a basis for evaluation of arms control inspection and verification concepts of the United States and other nations.

Headquartered in Washington, D.C., with a permanent staff, Project CLOUD GAP was commanded from September 1966 until recently by Maj Gen D. O. Monteith, U.S. Air Force, on assignment as project manager. His successor had not been designated when this article was written.

Nine of the 24 officers assigned to the headquarters at this time represented the Army, including Brig Gen Alvin E. Cowan as deputy project manager and Lt Col James H. Carroll Jr. as test director for CG-34. Both of these officers, well known to the Army R&D community, have recently been reassigned. Lt Col Harold L. James, USAF, is the new test director for CG-34.

The plan for conduct of a specific test such as CG-34 is developed by the CLOUD GAP staff in accordance with guidance formulated by the Steering Committee. Chairman is Lt Gen John J. Davis, USA, assistant director of ACDA in charge of the Agency's Weapons Evaluation and Control Bureau.

The Steering Committee is the mechanism established by the working agreement to ensure coordination of the views of interested and affected agencies on development of the test program, as well as the necessary review of its execution.

The committee consists of equal numbers of representatives of ACDA and DoD, the latter including members designated by the Joint Chiefs of Staff, the Director of Defense Research and Engineering, and the Director of the Defense Atomic Support Agency; a representative each from the Atomic Energy Commission and the Central Intelligence Agency; and a representative from each such other agency as the chairman may determine to be appropriate.

Lt Col James H. Carroll Jr. (right) receives congratulations from Brig Gen Alvin E. Cowan upon receiving the Joint Service Commendation Medal for achievements as test director of CG-34. General Cowan is deputy project manager for Project CLOUD GAP.

Through the Steering Committee, the ACDA provides the project manager with long-range guidance identifying those arms control and disarmament objectives for which appropriate measures would require inclusion of physical inspection as one of the means of verification to provide adequate assurance of compliance.

The presumption is that if physical inspection is required for any given arms control measure, the inspection system involved should be field tested to provide maximum confidence in the system. The committee also furnishes the detailed supplementary guidance on individual high-priority test requirements on the basis of which CLOUD GAP develops its field test concept and test plans.

Following coordination through and approval by the committee, a final test plan is forwarded by the director of ACDA to the Secretary of Defense, and to the heads of other agencies whose resources will be required, for final approval of resource commitments. The actual tests are conducted by a field-test organization developed from a nucleus of CLOUD GAP civilian and military personnel augmented by temporary duty personnel detailed from the military services.

As might be expected from the nature of the CLOUD GAP effort, a range of opinion exists as to the manner in which

---

Lt Col Louis G. Klinker, after serving a tour at HQ, Military Assistance Command, Vietnam, returned recently to the U.S. Army Research Office, (USARO), Physical and Engineering Sciences Division. He has served as chief of the Chemistry and Materials Branch, U.S. Army European Research Office, Frankfurt, Germany, and as chief of the Chemistry and Materials Branch, USARO, Arlington, Va. A graduate of Purdue University, the U.S. Army Management School, the Army Logistics School (Army R&D administration course), CBR School, and the Command and General Staff College, he is the author of a number of articles published in professional journals. Ten patents were granted on metallurgical processes he developed in private industry.

operations should be conducted. Suggested operations range from requirements for single trials, under conditions of relatively free play subjectively appraised, to specifically designed and controlled tests analyzed to develop quantitative expression of results.

The mission of Project CLOUD GAP is to field-test concepts, techniques, equipment and systems for inspection and verification designed to ensure compliance with particular arms-control agreements that might come into being, as well as to develop a body of experience and data to support negotiations. The question then arises as to what type of information would be most useful.

To determine what is negotiable, the capability of various inspection schemes under a variety of conditions must be known. For example, in negotiations on the inspection of production facilities, it is important to know the capability of various-sized teams under a variety of degrees of access, over a range of frequencies of inspection.

This capability must be determined for various types and sizes of facilities under the most complex evasion techniques that can be devised. Negotiations cannot simply deal with one condition representing one specific preselected value for each of these variables. The word "negotiate" itself implies adjustments, changes and modifications of the values chosen.

The next question which arises deals with the form in which information would be most useful. Is it adequate for the negotiator or decision-maker to be told that a specific inspection system works, or must he be supplied with quantitative data to enable him to know how well it works and to appreciate the consequences of changes in the conditions under which the system is to operate?

Assuming the statement is made that an inspection system "works well," what does it mean? Obviously it is someone's subjective judgment that depends on that individual's standards of adequacy and acceptability. The decision-makers need more. A measure of the performance of the system must be found.

In designing the CG-34 test, the planners understood that subjective results were important and useful but at the same time recognized that objectively measured products were indispensable.

As previously stated, CG-34 is related to what is known as the Transfer Proposal. As a means of curbing the nuclear arms race, the United States had earlier proposed that there should be a verified cutoff in the production of fissionable materials for weapons purposes. The Transfer Proposal is tied to this cutoff but goes a step further in that it would actually introduce reductions in nuclear weapons inventories.

While it would thus introduce an actual turndown in the nuclear arms race, the Transfer Proposal would not necessarily impinge upon the security interests of either side. It does not involve inspection of remaining nuclear weapons inventories, nor does it call for compromising such sensitive elements as weapons design.

It is in this latter context that field exercise CG-34 has an important role to play. It will undertake the thorough evaluation of the various techniques and equipment which have been developed to ensure that the transfer would operate as planned — providing reliable verification that the full measure of fissionable materials had been transferred to peaceful purposes, but without compromising weapons design in the process.

Obviously, this requires the development of rather sophisticated procedures which, to ensure complete realism, dictate the use of real weapons selected from the nuclear weapons retirement program.

Headquarters for the test is located at the U.S. Atomic Energy Commission's plant at Paducah, Ky. Actual operations are being conducted at the AEC facilities at Oak Ridge, Tenn., Golden, Colo., and Amarillo, Tex. CLOUD GAP inspection and test control teams are made up of approximately 80 military personnel.

For obvious reasons, details of test procedures and equipment have not been divulged. They are such, however, as to lend technical confidence in their capabilities to determine whether or not weapons are destroyed without compromising weapons design.

USAEPG Improves Infrared Test Target

An advanced infrared test target capability, previously not available at any Department of Defense installation, has been established through Air Force-Army cooperation at the U.S. Army Electronic Proving Ground, Fort Huachuca, Ariz.

The new target array consists of a combination of controller units for near infrared system testing and a set of passive panels with special coatings to provide a range of contrasts in "middle through far" infrared.

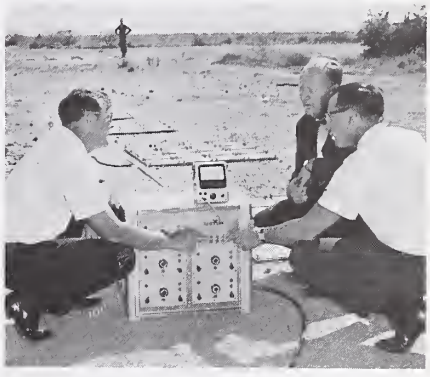
Controller units are building-block units consisting of one-foot square elements which are tied together to form a series of square panels. The passive panels are canvas and consist of seven 40-foot, square panels and one 200-foot, L-shaped panel known as an edge target. These panels have been calibrated from 2.5 to 22.2 microns by the National Bureau of Standards.

The targets are portable and with the appropriate radiometric monitoring equipment can be used in any area in which they can be tied down. This enables the USAEPG to test an infrared system using a variety of background terrain, such as grassy fields, woods and open desert.

Development of the target resulted from test requirements established by the Surveillance Division of the Test Directorate at USAEPG for an accurate way to measure the thermal sensitivity of an infrared system.

Targets formerly used at the Proving Ground were designed to provide system resolution data, but could not accurately measure system sensitivity. With the new system, the modulation transfer function also can be evaluated.

CANVAS PANELS of infrared target are laid out by USAEPG personnel.



CONTROLLER UNITS for active infrared target array are checked out by USAEPG Test Directorate project engineers Richard W. Moody, Range Division, Colin M. Giorgi, Instrumentation R&D Division, and Ervin R. Crowther, Surveillance Division.

Credited with the advance in the infrared target research effort are the Instrumentation Research and Development Division and the Range Division at USAEPG, and the Photographic Branch, Directorate of Reconnaissance Engineering, Wright Patterson Air Force Base, Ohio.

Huachuca Holds Surveillance Course

Thirty-eight key officers and Department of the Army civilians, representing military installations throughout the United States, participated in the first of five 3½-day courses in combat surveillance.

The course was conducted last month at the U.S. Army Combat Surveillance Training Center, Fort Huachuca, Ariz., commanded by Col Roy A. Kane. Instruction included familarization with combat ground and aerial surveillance equipment, and demonstrations in tactical employment.

Mathematics Research Center Lists Academic Staff

Mathematicians from several countries and institutions comprise the 1967-68 academic year staff of the Mathematics Research Center (MRC), U.S. Army, Madison, Wis.

Established in 1956 at the University of Winconsin, the MRC performs, on contract, research in applied areas of mathematics related to military needs.

Staff members furnish assistance and guidance as requested by authorities at Army installations. The MRC offers orientation lectures, symposia, advanced seminars and extended residencies to Army personnel.

Staff members on leave from educational institutions keep the center apprised of the latest trends in mathematics. Former members serving again this year, and their fields of specialization, are:

Donald Greenspan (on leave), numerical solution of differential equations; Thomas N. E. Greville, approximation theory and actuarial mathematics; Bernard Harris, statistics; Te Chiang Hu, integer programing and network flows;

Joseph W. Jerome, approximation in function spaces; Herman F. Karreman, stochastic optimization and control; Rudolph E. Langer (emeritus), differential equations; Henry B. Mann, number theory and statistics; Ben Noble, integral equations and numerical analysis; and

Louis B. Rall, numerical analysis, integral equations, and functional analysis; J. Ben Rosen, nonlinear programing and optimal control theory; J. Barkley Rosser, logic and numerical analysis; Isaac J. Schoenberg, analysis and approximation theory; and

Larry L. Schumaker, approximation theory; J. Michael Yohe, computer programing and topology; E. H. Zarantonello, analysis and functional analysis.

University of Wisconsin staff members serving at the MRC are Patrick R. Ahern, analysis; Richard Askey, special functions; G. E. P. Box, (spring semester), design of experiments, industrial statistics, and forecasting and control; James W. Daniel, numerical analysis; and

H. Reynold Fiege Jr., application of operations research and computers to medical problems; Jerome H. Klotz, nonparametric statistical methods; O. L. Mangasarian, mathematical programing and optimal control; Richard E. Meyer, fluid dynamics, geophysics, nonlinear partial differential equations and asymptotics; and

John E. Olson, combinatorial analysis; George W. Swan, elasticity and magneto-hydrodynamics; Larry E. Travis, artificial intelligence; Michael Voichick, analysis; Stephen Wainger, fourier analysis; and Lawrence C. Young, set theory, integration and calculus of variations.

Other members of this year's MRC staff are Horst E. H. Becker, Tech. Hoch. Karlsruhe, applied mathematics; James H. Case, University of Michigan, control theory and differential games; John M. Danskin, Institute for Naval Analysis, operations research; S. C. R. Dennis, University of Western Ontario, numerical solution of hydrodynamic problems; and

Martin Fox, Michigan State University, statistical inference and probability; Morton A. Hyman, IBM, Bethesda, Md., numerical analysis; George S. Kimeldorf, Calif. State College, Hayward, bayesian inference and actuarial mathematics; Dahlard L. Lukes, Honeywell Corp., Minneapolis, control theory, differential equations and games; V. S. Mandrekar, University of Minnesota, stochastic processes; and

Robert E. O'Malley Jr., Courant Institute, differential equations, singular pertubations and asymptotics; Patricia M. Prenter, Colorado State University, measure theory; Minoru Urabe, Kyusku University, Tokyo, numerical analysis; and

John R. Whiteman, Royal Military College of Science, numerical analysis and elliptical boundary value problems; James S. W. Wong, University of Alberta, Canada, ordinary differential equations and functional analysis; and Anton J. Zettl, Louisiana State University, ordinary differential equations and boundary value problems.

Project THEMIS Pamphlet Invites 2nd-Year Bids

Project THEMIS, Department of Defense program to expand and strengthen centers of scientific excellence in the nation's advanced academic institutions, will move into the second-year phase with the distribution this month of a revised brochure to more than 200 colleges and universities.

Institutions must submit preliminary proposals for research by Dec. 22, 1967, for the 1968-69 academic year. Approximately 45 new research programs will be assigned.

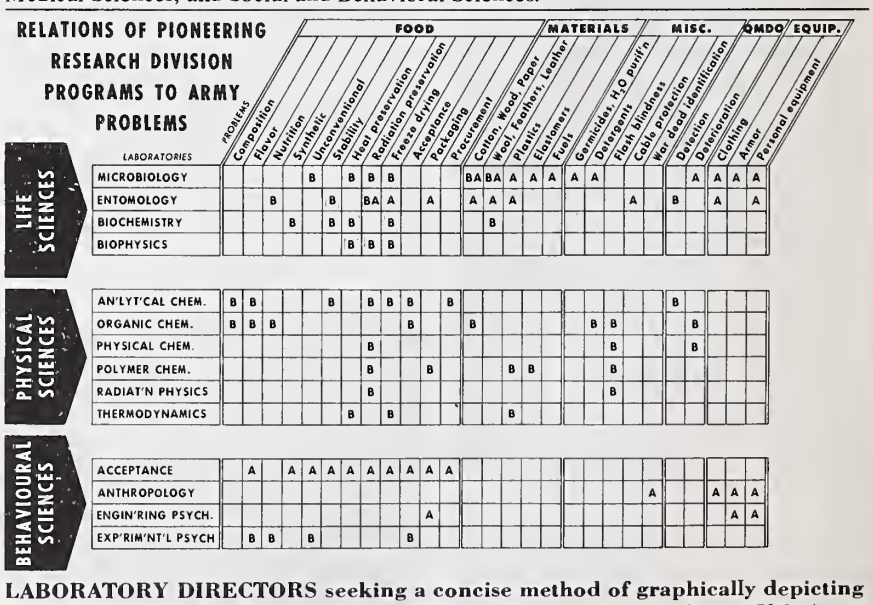
For the current academic year, 50 contracts were awarded in the eight "problem" categories outlined by the Office of the Director of Defense Research and Engineering (ODDR&E). Thirty states and the District of Columbia share in this $20.5 million allocation of THEMIS funding.

The Army was granted research in 15 areas, the Navy 17, the Air Force 13, and the ODDR&E Advanced Research Projects Agency (ARPA) 5.

Preliminary proposals submitted for the next year will contain detailed descriptions of proposed work. Following a thorough analysis, selected proposals will be returned to proponents for additional details upon which to base Department of Defense contract decisions.

Project THEMIS favors institutions which have not previously received substantial support in the long-established DoD research programs in universities and colleges. With a step-funding plan developed in THEMIS planning, commitments can be made three years in advance, which provides the long-desired continuity of funding base.

General technological categories detailed in the THEMIS brochure include Detection, Surveillance, Navigation and Control; Energy and Power; Information Sciences; Military Vehicle Technology; Material Sciences; Environmental Sciences; Medical Sciences; and Social and Behavioral Sciences.



LABORATORY DIRECTORS seeking a concise method of graphically depicting areas of effort in major scientific disciplines and their relationship to U.S. Army problems may find cross-fertilization of ideas to meet requirements in this chart. It was developed by the U.S. Army Natick (Mass.) Laboratories. *B* denotes basic research activities. *A* denotes applied research (exploratory development).

Modified Standard Rifles Fire Caseless Cartridges

Caseless cartridges for small arms, developed in stages over the past eight years at Frankford Arsenal, Pa., have been successfully fired in modified standard Army rifles and machineguns.

One of the most recent reports on the molded, solid-propellant cartridge was presented in June at the second Solid Propulsion Conference, sponsored by the Interagency Chemical Rocket Propulsion Group (ICRPG) and the American Institute of Aeronautics and Astronautics.

Research chemist Joseph B. Quinlan of Frankford's Pitman Research Laboratories outlined the experimental development of the caseless charge, pointing out its advantages and the "formidable requirements" such a revolutionary development must satisfy.

Frankford chemists have developed caseless rounds for various caliber weapons. The 7.62mm cartridge firings in the M14 rifle and M73 tank machinegun at various rates were described in the paper. Both types of arms required modifications to accept the caseless round.

The Frankford studies have "progressed through a 3-stage metamorphosis — a molded charge in a split case, a metal stub-obturated (sealed) caseless charge, and a completely combustible caseless cartridge capable of functioning in a self-obturating test weapon."

Exhaustive tests were performed on the molded charge, including impact sensitivity, extreme temperatures, mechanical strength, immersion in water, and effect of molding pressure. Ballistic results were reported to meet standards set for the 7.62mm ammunition.

Some of the advantages of caseless ammunition in which the only metal component is the projectile were listed as follows:

- Elimination of spent cases in tanks and planes.
- Elimination of the need for machine tools and of the use of critical brass required for metal cartridge cases.
- Substantial reduction in cartridge weight and volume would allow fighting men to carry more rounds. (The standard 7.62mm 387-grain ball cartridge is 2.8 inches long; the caseless counterpart, 196 grain, is 2.0 inches long, about half the weight and two thirds the volume of the standard round.)
- Cost of manufacture and use of critical materials would be reduced.
- Eliminating the need to extract and eject cartridge cases from the gun "could result in a higher rate of fire and a shorter and lighter receiver for any weapon employing a caseless cartridge."

Problem areas seen in the development of caseless cartridges for general use "which need further evaluation and solution" include:

- "Cook off," the ignition of the propellant in the gun before the trigger is pulled, may occur even with brass cartridges under a prolonged firing schedule.
- Erosion of firing pin and bolt face is caused by the properties of the combustible primer composition.
- Some means must be found to remove or refire a misfire in the absence of a case which can be ejected.
- Development of a technique is needed to manufacture caseless ammunition with high-speed equipment.
- Satisfactory storage and handling methods must be developed.

R&D Center 'Snows' Equipment With New Spray-On Camouflage

"Snow job" usually means that someone is doing some screen talking — kind of camouflaging the facts, so to speak. That's what makes the term so appropriate as used now at the U.S. Army Mobility Equipment Research and Development Center.

Personnel at the Fort Belvoir, Va., installation apply a "snow job" to equipment or facilities as a camouflage that blends into a snow-covered landscape.

Developed by the center's Materials Research Support Laboratory, the mixture can be applied by spray or brush. It can be applied by troops in the field at temperatures of -30°

Intended to replace whitewash in certain applications, the material dries within a half-hour, and is very resistant to abrasion, moisture and moderate heat. It can be removed simply by spraying with a mild alkaline aqueous solution, without damage to the underlying surface.

Jumbled Names . . . or Faces?

Army Research and Development Newsmagazine *readers who know Lt Cols Joseph T. Tambe and Vito Stipo were quick to call to the attention of the editors the transposition of their names (or pictures) on page 23 of the September edition. Within moments after the Newsmagazine was distributed, the editors' phones were rather busy!*

That was bad enough, all by itself, but the error had to be compounded as far as Lt Col Tambe was concerned. The article said he received both his degrees from Ohio State University, where he did receive an MA degree. His BA degree in psychology was earned at Ohio University.

In a still, small voice, "Confound that printer!" But we are sorry!

First Gun-Fired Missile Mounted on Tank

America's first guided missile to be fired from a gun has gone into service with the U.S. Army. The first units of the deadly accurate Shillelagh system have been issued to a tank battalion at Fort Riley, Kans., and are mounted as an integral part of the General Sheridan Armored Reconnaissance Airborne Assault Vehicle.

Fort Riley will serve as one of the crew training centers for the Sheridan/Shellelagh system to establish combat operational capability. The Shellelagh tactical antitank missile weapon has been type classified Standard A by the U.S. Army.

In addition to being standard armament on the General Sheridan vehicle, the Shillelagh is being adapted to the Army's M60 A1E1 Battle Tank and will also be standard weaponry on the joint U.S.-Federal Republic of Germany Main Battle Tank.

The Shillelagh missile system is now in production by Philco-Ford Corporation Aeronutronic Division at the government-owned U.S. Army Missile Plant at Lawndale, Calif. U.S. Army responsibility for the Shillelagh missile system is held by the Missile Command, with Col Spencer R. Baen as project manager.

Antiballistic Missile Defense Linked to Army Efforts

(Continued from page 4)

unable to deter the Soviet pressures against Berlin, or their support of aggression in Korea. Today, our nuclear superiority does not deter all forms of Soviet support of Communist insurgency in Southeast Asia...

"How can we be so certain that the Soviets cannot gradually outdistance us — either by some dramatic technological breakthrough, or simply through our imperceptible lagging behind, for whatever reasons: reluctance to spend the requisite funds; distraction with military problems elsewhere; faulty intelligence; or simply negligence and naivete?

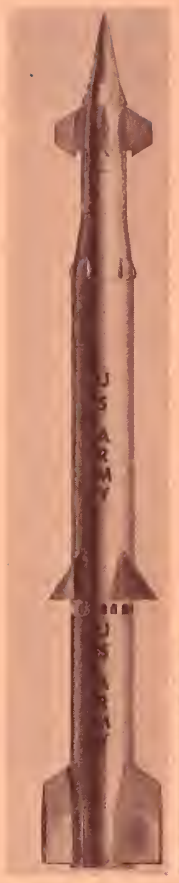
. . ."We are not going to permit the Soviets to outdistance us, because to do so would be to jeopardize our very viability as a nation. No President, no Secretary of Defense, no Congress of the United States — of whatever political party, and of whatever political persuasion — is going to permit this nation to take the risk. . . .

"But what we would much prefer to do is to come to a realistic and reasonably reckless agreement with the Soviet Union which would effectively prevent such an arms race. . . .

"Man is clearly a compound of folly and wisdom — and history is clearly a consequence of the admixture of these two contradictory traits. History has placed our particular lives in an era when the consequences of human folly are waxing more and more catastropic in the matters of war and peace.

"In the end, the root of man's security does not lie in his weaponry. In the end, the root of a man's security lies in his mind.

"What the world requires in its 22nd Year of the Atomic Age is a new race towards reasonableness. We had better all run that race. Not merely we the administrators. But we the people. . . ."



13th AUSA Meet Features Military-Industry Exhibits

The 13th Annual Meeting of the Association of the U.S. Army, held at the Sheraton-Park Hotel in Washington, D.C., Oct. 9-11, featured more than 100 industrial and military exhibits. Among these were (1) Spartan Missile, (2) CH-47 Chinook carrying 105mm howitzer, (3) OH-6A Cayuse, (4) AH-1G Hueycobra, (5) AH-56A Cheyenne, (6) MBT–70 Main Battle Tank being developed jointly by the United States and Federal Republic of Germany, (7) Chaparral Air Defense System mounted on XM-730 tracked vehicle, (8) Vulcan Air Defense System mounted on Army M113 armored personnel carrier.